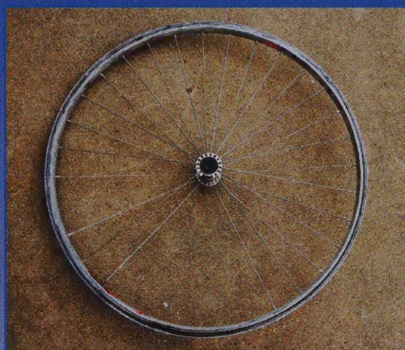
YOUR CONSTRUCTION AND OPERATING QRP SOURCEBOOK

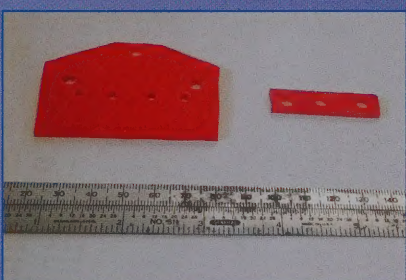
QRP Quarterly

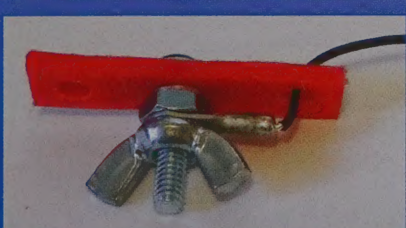
Volume 57 Number 1
January 2016

Journal of the QRP Amateur Radio Club International

Antenna Parts from Cutting Boards and Bicycle Wheels? (See the 'Idea Exchange' – pg 6!)







- MØXPD Designs a Parallel IF Board for the "Let's Build Something" Transceiver
- The "1Watter" as a Morse Code Teaching Tool (and a Review) by K7QO
- KH2SR Reviews the LD-5 HF SSB/CW Transceiver
- AE6TY Analyzes Second Harmonic Suppression and Inter-station Interference

QRP ARCI℠ is a non-profit organization dedicated to increasing worldwide enjoyment of radio operation, experimentation and the formation and promotion of QRP clubs throughout the world.

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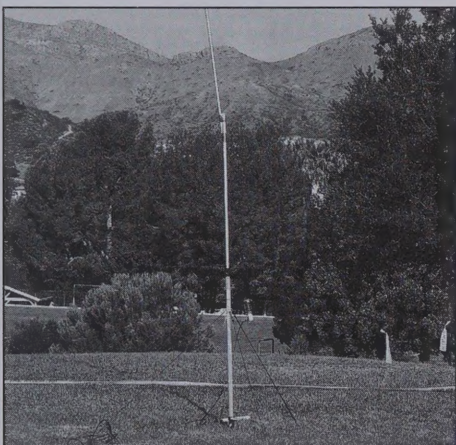

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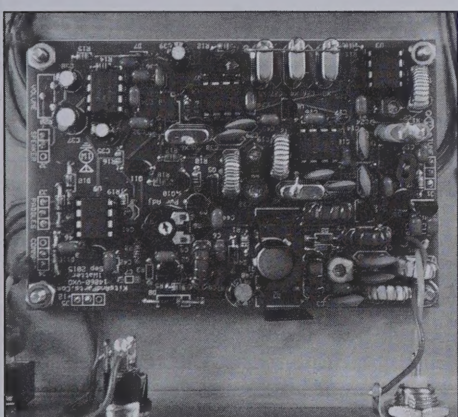

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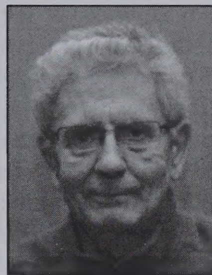
Tim Stabler—WB9NLZ editor@qrparci.org



Well, here we are at the beginning of a new year. I am sure you have something in your New Year's resolutions about your QRP shack. I know I do, but I am keeping everything quiet so I do not have to answer questions why it's not done yet.

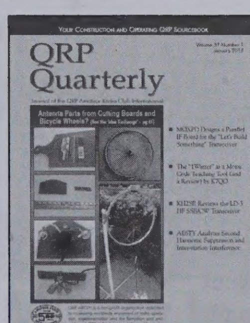
Have you made your reservations for FDIM 2016, yet? Initial information in on the next page, and as always, look for it on the QRP ARCI website: www.qrparci.org/FDIM/

So get the scoop and reserve away!

As happens to all of us, especially around the holidays, many things have come up for me to do lately and radio has had to take a back seat. So I really do not have any new experiences to write about. I am sure there will be plenty for the next issue.

Anyone out there have a project you are working on? If so, write it up and send it in. That also goes for clubs. I need your information for the Clubhouse column. Also, we are still looking for a technically-oriented Associate Editor to help recruit authors and review incoming articles. Just contact me or anyone else on the *QQ* Staff list on this page.

—72/73 de WB9NLZ



On the Cover

Joe Everhart, N2CX is a regular contributor to the 'Idea Exchange' with his series of Quickies. In this issue, he describes a portable dipole setup using plastic from a dollar store cutting board for center and end insulators.

Then, Ben Kuo, KK6FUT recycles (pun intended) a bicycle wheel rescued from the trash, creating a compact transmitting loop for portable or stealth hamming.

The Idea Exchange begins on page 6.

From the President

Steve Fletcher—G4GXL president@qrparci.org

QRP ARCI, like most amateur radio organisations, relies on volunteers to support all of the activities that are enjoyed by the membership. Some are prepared to spend many hours each month on club duties. Craig Behrens NM4T is one of those can-do guys who has written for *QQ*, presented at FDIM and manned the club booth at hamfests. At FDIM 2015 Craig managed the registration evening—I think that one needed a small amount of arm twisting, but he stepped up and did a great job. Unfortunately Craig is having to cut down on some of his activities for health reasons —he will be missed on the QRP ARCI Board. Thanks for all of your help over several years Craig. I hope we can see you at FDIM some time and maybe receive the occasional article for the *QRP Quarterly*.

Two of our busiest volunteers are Jack Nelson K5FSE and Charlotte Nelson KJ4EDM. Jack is Treasurer and Toystore Manager, while Charlotte processes subscriptions in her role as Membership Secretary. Charlotte in particular puts in a huge amount of effort to process subscription payments, maintain the membership database and deal with queries. Spare them a thought next time you renew your subscription. By the way—check your mailing label now or look up your renewal date online at: www.qrparci.org/join-renew

Ed Breneiser WA3WSJ took on the Awards Manager role in 2015. He has updated the awards and succeeded in making the program more popular than ever. Ed has now decided to move on to some other activities. Let me know if you are interested in taking on the Awards Manager role. The responsibilities include checking applications, printing and mailing certificates. You will need to be well organised, able to maintain records on a spreadsheet, have just a little bit of computer graphics ability and be prepared to submit updates to *QQ*.

I mentioned last time that the Contest Manager post was vacant. This is a difficult role—the contest schedule is in need of a long overdue overhaul. We think an announcement will be made online soon, but sadly, the first two or three contests of 2016 have had to be cancelled.

Aside from the volunteer staff positions *QRP Quarterly* could not exist without input from members. If you have technical skills then please consider submitting a project. Maybe you are not a designer - so how about reviewing a kit or reporting on a recent antenna build. If you enjoy operating outdoors then send us the story and plenty of photos !

The QRP Clubhouse feature is there to support local clubs and groups. It would be great if someone at each QRP club could volunteer to send in a short report of your recent activities. It would help to promote your own group and may also act as a catalyst to encourage similar activities in other clubs. Next time you have a meeting see if you can persuade someone to send in a report (or do it yourself). We might even be able to supply a few raffle prizes for clubs sending in contributions !

FDIM (Four Days In May) 2016

Registrations can now be made for our annual convention at Dayton. Last year was a sellout so be sure to book early. Full details are online at www.qrparci.org/fdim

QRP Hall Of Fame

The banquet at FDIM is traditionally the place where hall of fame inductees are announced. Anyone can be nominated and anyone can be a nominator; QRP ARCI membership is not a pre-requisite. All nominations should be sent by email to both Steve Fletcher G4GXL (president@qrparci.org) and Preston Douglas WJ2V (vp@qrparci.org). You must submit your nomination to both officers, the deadline is 20 March 2016. The voting panel includes the QRP ARCI Board Members, President, Vice-President and recent inductees to the QRP Hall Of Fame. Remember to tell us why you think a person should be considered. We need to know what contribution they have made, in terms of actions, impact and length of service.

You will need to check the HoF Nomination Guidelines on the QRP ARCI website—www.qrparci.org

—72, Steve Fletcher, G4GXL
President, QRP ARCI

●●

QRP ARCI Awards

Ed Breneiser—WA3WSJ awards@qrparci.org

Award Notes—If you are an active QRP ARCI Member (which means you receive QQ) all awards are free. But, awards are limited to five free awards per calendar year. After five awards are issued in one year, each award is $10.00 (USD) each. This change in award policy started in 2015.

If you are not an active QRP ARCI Member, each award will cost you $10 (USD). If you just renewed your membership, please state this on your award application as I look at the website to see if you're an active member before processing any award without payment etc. If you send a payment or donation for an award, please state this on the application.

Who Got What in the Last Quarter?

QRP KMPW Awards:

NØQLT	#4046	2496 mpw
VE3CBK	#4047	1139 mpw
VE3CBK	#4048	1062 mpw
VE3CBK	#4049	1078 mpw
VE3CBK	#4050	1062 mpw
VE3CBK	#4051	1065 mpw
VE3CBK	#4052	1024 mpw
VE3CBK	#4053	1003 mpw

VE3CBK	#4054	1002 mpw
VE3CBK	#4055	1015 mpw
VE3CBK	#4056	1099 mpw
VE3CBK	#4057	1101 mpw
VE3CBK	#4058	1132 mpw
VE3CBK	#4059	1123 mpw
VE3CBK	#4060	1559 mpw
VE3CBK	#4061	1218 mpw
VE3CBK	#4062	1217 mpw
BG8IL	#4063	1808 mpw
W4FSV	#4064	11,028 mpw
NE6I	#4065	1329 mpw
EA8/MØJCQ	#4066	10,293 mpw
SQ5TB	#4067	1351 mpw
VE3CBK	#4068	1082 mpw
VE3CBK	#4069	1024 mpw
VE3CBK	#4070	1069 mpw
VE3CBK	#4071	1084 mpw
KB9BVN	#4072	1103 mpw
KC4ATV	#4073	1563 mpw
K1QN	#4074	1152 mpw

QRP 10-Band KMPW Awards:

K1QN	#2

QRP All States Awards:

W4VAB/Ø	#111	CW, Portable
W4JBB	#112	Mixed

QRP All Continents Awards:

W4FSV	#110	CW

QRP KMPW-100 Awards:

JH1GNU	#1	CW, 10 MHz

QRP DX Awards:

KA5PVB	#107	SSB
VE3CBK	#108	14 MHz, SSB
AA8MI	#109	CW, 150 DX Countries

QRP Grid Square Awards:

SQ5TB	#31	200, 10m, PSK31
WI5H	#32	CW

Idea Exchange

Technical Tidbits for the QRPer

Mike Czuhajewsi—WA8MCQ wa8mcq@verizon.net

In this edition of the Idea Exchange:

Portable Tri-Band Balanced Dipole—N2CX

Desoldering Aid for Surface Mount Devices—VE3UTE

HF Loop Antenna from Bicycle Rim—KK6FUT

Portable Tri-Band Balanced Dipole

Heading inexorably toward the century mark, here is #95 in the endless series of Technical Quickies promised to me long ago by Joe Everhart, N2CX—

I love QRP portable hamming. It's great when the weather cooperates so that the enjoyment of being outdoors can be combined with my hamming hobby. One of the greatest things about going portable is that a ham can also experiment with antennas. But in spite of forays into the worlds of quarter wave verticals, end fed half wave antennas and magnetic loops we always come back to center fed dipoles as the best performers. They may take a little more work than other skywires but their best characteristic is consistency. With enough room to string them out and convenient supports they rarely fail to just plain work, with no fuss or muss. This Quickie describes my current favorite way of building them.

As most hams know, a center fed half-wave dipole is simply two quarter wave-length wires fed with some sort of feedline in the middle as in Figure 1. A good starting point for the quarter wave wires is L=234/F where L is the length in feet and F is the operating frequency in MHz. We'll get into the feedline later, but the easiest setup for the half-wave dipole in portable operation is to use an inverted vee configuration, shown in Figure 2. The center of the antenna is where most of the signal is radiated from so it should be as high as possible. Practically speaking, this needs to be at least 25 feet above ground. The ends can be as low as 8 feet or so high, so as not to "clothesline" innocent bystanders. As with the center, higher is better, particularly for DX.

In addition to requiring only a single high support, stringing up a dipole as an inverted vee also has the advantage that the wires do not have to support the antenna's whole weight so inexpensive light-weight hookup wire at least 22 gauge or more is adequate. While solid conductor wire is usable, stranded wire is less likely to kink during setup and takedown so it lasts longer. PVC or PTFE insulation is not needed, strictly speaking, but if that's what you have there is no need to strip it off.

The most convenient type of feedline is coaxial cable. It is relatively lightweight, closely matches the dipoles impedance (at least for single-band operation) and with proper connectors goes right into your rig with no fuss or muss. But wait, you say, that's only good for single band operation. Yes, grasshopper, that's true, but there are ways to handle that matter. We will see how shortly. Though purists may complain that it is lossy, I find that RG-174 is a good choice. For lengths of 30 feet or so its small loss at HF is far outweighed by its light weight and predictable performance when used properly.

Though I have built numerous dipoles over my 50 year hamming career that fed the dipole directly with coax, I've found that they work much more predictably when you use balanced feed. Now this doesn't mean a balanced feeder such as open wire line or twinlead, but merely a *balun* or balanced-to-unbalanced device to couple the balanced dipole antenna to the unbalanced coaxial feedline. Figure 3 is a simple sketch of this setup.

My favorite simple balun is a choke balun that presents a high impedance to antenna currents that might want to flow on the outside of the shield. Joe's Quickie No. 83 (Ref. 1) describes just such a choke balun and why it is important. It's made simply by winding 10 or 12 turns of the RG-174 feedline on an FT114-43 ferrite toroidal core. Figure 4 is a photo of the choke balun from Quickie 83, which was mounted in a box with connectors. The one

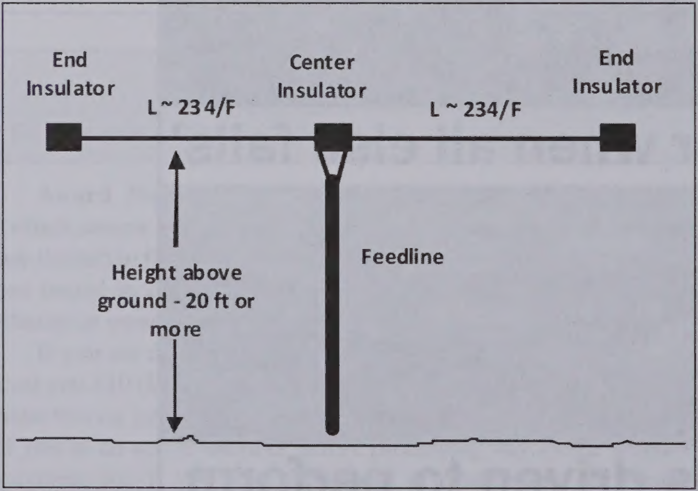


Figure 1—Half wave center fed dipole.

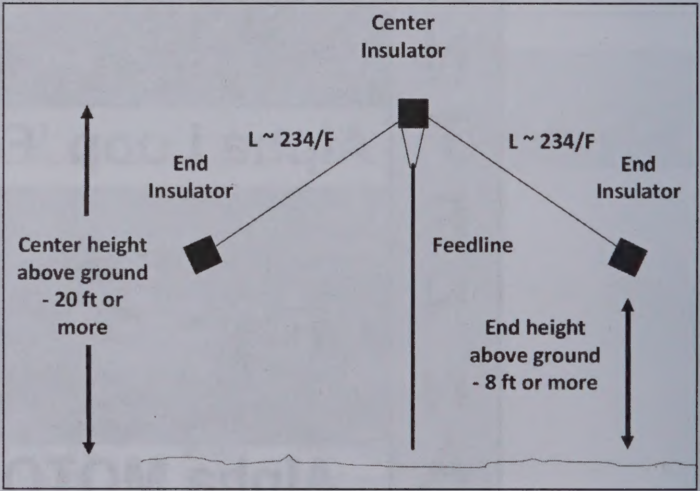


Figure 2—Half wave dipole inverted vee configuration.

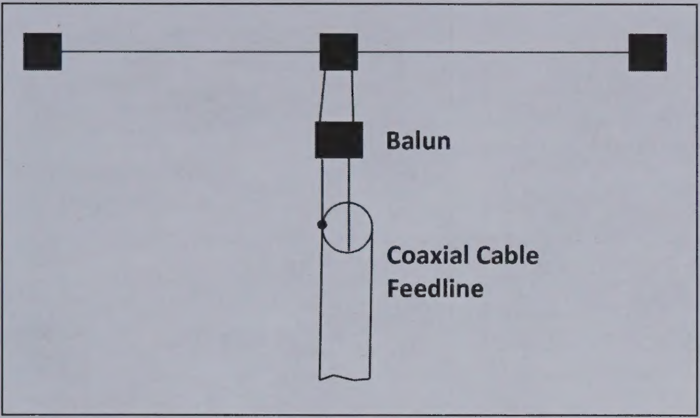


Figure 3—Dipole fed with coax through a balun.

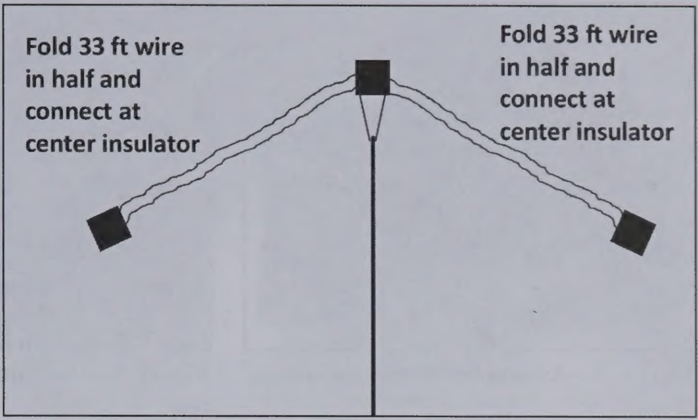


Figure 5—Fold back dipole ends to cover 20 meters.

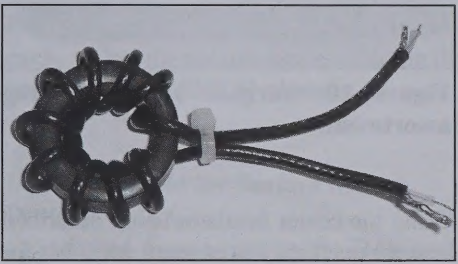


Figure 4—Balun from Quickie #83.

used on the antenna in this Quickie is slightly different since the feedline is wound directly on the core.

This balun is quite suitable for this application. It's easy to make, lightweight, and will handle far more than QRP power levels. The cores can be obtained from several sources, but my favorite is the popular QRPers parts supplier www.kitsandparts.com. No pecuniary connection, by the way.

As mentioned earlier, simple coax-fed dipoles are generally usable on only one frequency band. However, there are some simple tricks that can make them multiband. The first is useful for a 40/20/15 meter antenna. A 40 meter dipole is about twice the length of a 20 meter dipole. If you simply fold back each half of the dipole and connect the ends to the center, the 40 meter antenna is now resonant on 20 meters as shown in Figure 5. Running the numbers, you can see that if cut for the QRP CW part of 40M, 7.035 MHz, the length of each leg is 33.26 feet, which corresponds to 14.07 MHz when folded in half—not bad!

The other trick is that a half-wave dipole is also resonant with a low impedance as a 3/2 wave dipole. Thus a 7 MHz (40 meter) dipole is also resonant on 21 MHz (15 meters). There is a slight issue with this, though. Due to what is called "end effect" the 3/2 wave dipole is resonant slightly higher than three times the original frequency. So a 40 meter dipole cut for the QRP CW part of the band will be resonant at the high end of the 15 meter band and will likely show an SWR of over 2:1 in the QRP CW part of the band. If your rig can handle this, no problem. If not, you need an antenna tuning unit (ATU) to get the SWR down low enough.

Alas, the WARC bands are not harmonically related so there is yet another trick to get multiband operation on them with a coax fed dipole, called the segmented dipole, but that's a topic for a possible future Quickie.

In keeping with the theme of a simple lightweight antenna, the insulators used for the center and end connections are homebrew and made of easily available plastic material. Always looking for stuff usable for purposes not originally intended, I found handy material at my local Dollar Store. They sell plastic kitchen cutting boards in their housewares section that are very handy. They are made of either red or white HDPE material that's about 1/8" thick. Figure 6 is a photo of a typical sample.

Attempts to cut it to shape with tin snips resulted in lots of cracked plastic. Fortunately a power jigsaw works just fine. Figure 7 shows an early attempt at making a center insulator with nothing installed on it. there were several other "cuts" at making something large enough to be useful until I finally got things exactly right. The large holes are 3/16" for hardware and mounting, while the smaller holes are 1/8" for wire ties used to hold the balun in place.

The final center insulator is illustrated in Figures 8 and 9. The balun core has 12

Figure 6—Dollar Store cutting board.

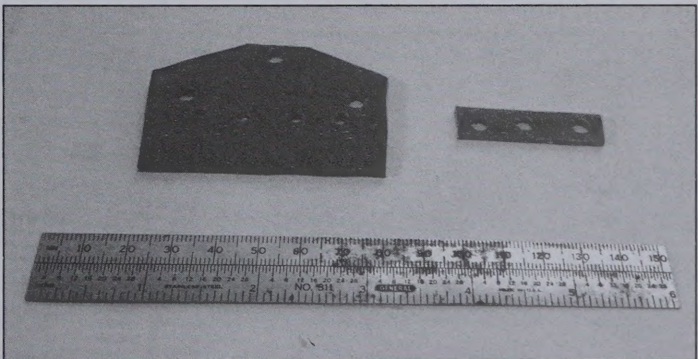


Figure 7—Early attempt at center and end insulators.

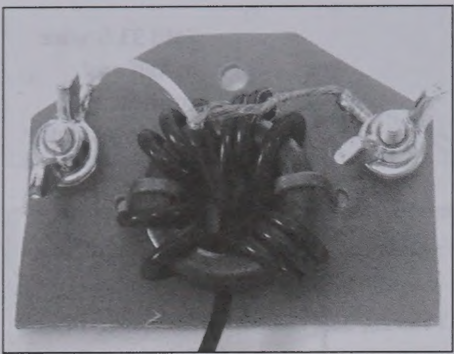


Figure 8—Assembled center insulator, front view

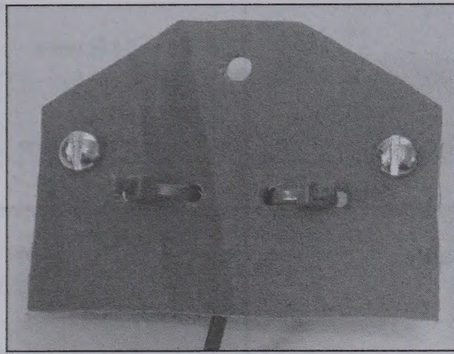


Figure 9—Assembled center insulator, rear view.

turns of the RG-174 feedline wound around it and held in place with a couple of plastic cable ties. This secures it and provides strain relief for the coax feeder. About 2 inches of the end of the coax is stripped back and separated for connection to the wires. Ring lugs are soldered onto the ends of the coax leads and secured by some #8 hardware—use of stainless steel is best for long-term usability. Note also use of wing nuts for quick connection and disconnection.

Although not shown in the picture, it might be a good idea to seal the coax braid with some "liquid tape" from your local hardware megastore to keep moisture from deteriorating the coax. Dipole leads are secured to the insulator and connected to the balun leads by the same hardware.

Ring lugs are used for connections in this design to give good electrical and mechanical integrity. As with the insulators, I was able to find suitable ring lugs at a local bargain store, although not the same chain as the cutting board. Figure 10 shows the package. Not all are the right size, but there are enough in each package for several antennas and they are much more economical than the local hardware store. I did not use the lugs in the usual way. While crimped connections are fine for most uses, I don't trust them to be too strong mechanically so they are soldered as well.

The plastic sleeve is pulled off each lug, the wire is crimped on, then the wire is soldered, as shown in Figure 11. If you want added strain relief you can apply some shrink sleaving over the lug after soldering the wire in place.

The end insulators serve double duty. For the 40/15 meter dipole, the full wire length is used so the ring lug is attached to the center of the insulator. For the 20 meter configuration, the wire is removed from the screw, looped back and connected to its other end at the center insulator. Figures 12 and 13 show both setups.

A common issue with portable wire antennas is dealing with the wires and cables for storage and deployment. A simple answer is to use some sort of wire winder. I won't go into that in this Quickie since it's already been discussed in an earlier one (Ref. 2). In short, though, I recommend the excellent wire winders available from SOTAbeams. (As with the other vendors, I have no financial connection with this outfit.): www.sotabeams.com

This Quickie shows a particular three band antenna configuration. There is no reason at all that the dipole legs couldn't be cut for any single band in the HF region.

Figure 11—Solder lug installation on wire.

Figure 10—Bargain store ring lug assortment.

Using the center insulator/balun described here makes it easy to connect wires cut for the band of your choice to get good, solid repeatable performance from our portable antenna.

References:

1. Joe's Quickie #83, "Quickie Choke Balun," *QRP Quarterly*, October 2012 Idea Exchange.

2. Joe's Quickie #84, "Wire Management for Portable Operation," *QRP Quarterly*, January 2013 Idea Exchange.

—DE N2CX

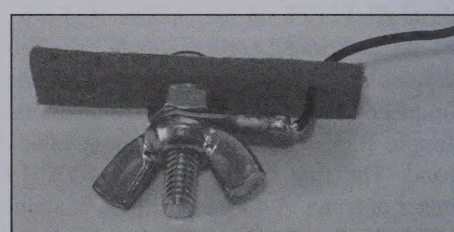


Figure 12—40/15 meter end insulator setup. The entire wire length is used.

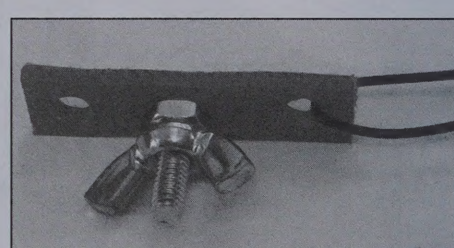


Figure 13—20 meter end insulator setup. The wire is looped back to the center.

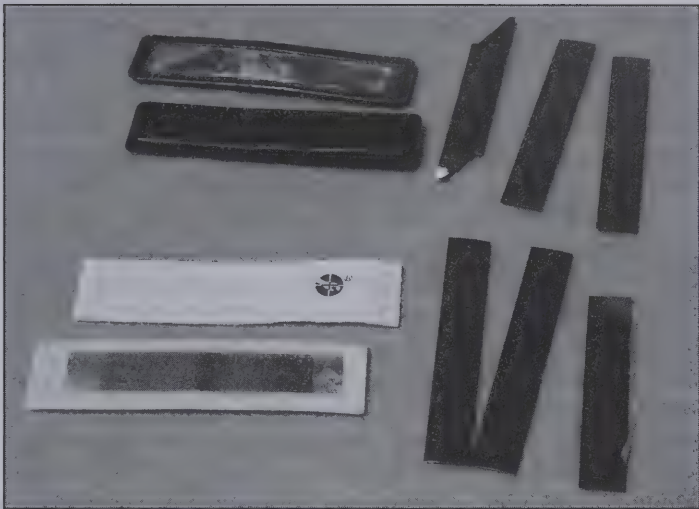


Figure 14—Anti-theft security tags, with 3 metal strips in each. Although not obvious due to the lighting, they are bright and shiny. [WA8MCQ photo]

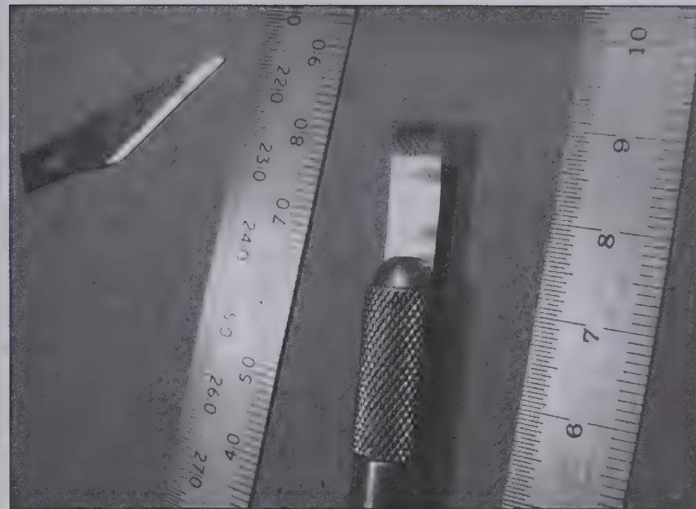


Figure 15—One of the strips in an Xacto knife blade holder. The thickest one will last longer. (The rulers are metric.) [VE3UTE photo]

Desoldering Aid for Surface Mount Devices

Adapted from a post to the TekScopes forum on yahoogroups.com, this comes from Robert Legg, VE3UTE. (He later provided some of the photos.)

Figure 14 shows some of the older security tags used to reduce shoplifting, in a CD or DVD case, for instance. Inside the adhesive-backed package you'll find three lengths of crystalline-nickel steel strip. Two are 0.001" thick and the third is two thousandths. The latter strip is fit into an Xacto knife blade holder (Figure 15).

By slipping the strip under the body of an SMD device (Figure 16), you can reheat pins one at a time and slip the shim into the interface, without stressing the pin or the board. No solder will stick to it.

Some of the strips are cut at an angle, seen in the top of Figure 14. This is marginally easier to work into the heated joint from underneath the chip, moving outwards.

I use this method in any instance where the part must be saved for examination or re-use, or if the board is irreplaceable. Once the chip is removed, residual solder can be reflowed evenly to provide a clean working surface for the new part.

Try the technique on junk or scrap first. A magnified, well-illuminated visual aid is recommended for any manual SMD rework.

A clean, fine tip soldering iron with 60/40 solder is recommended.

WA8MCQ notes: Although the bodies of many surface mount parts are spaced slightly above the board and allow the shim to slip in easily underneath, he later said that this is not always the case and there is sometimes zero clearance. You can still use the tool but access to the solder joint will be trickier.

—DE VE3UTE

HF Loop Antenna from Bicycle Rim

From Ben Kuo, KK6FUT—

I'm always looking for cheap, easy ham radio projects to try something or learn something new, so I was very happy

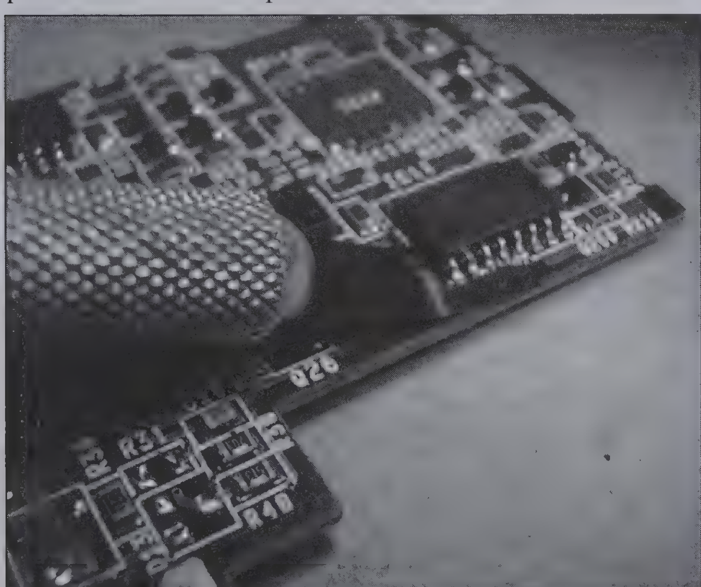


Figure 16—The desoldering tool in use. [VE3UTE photo]

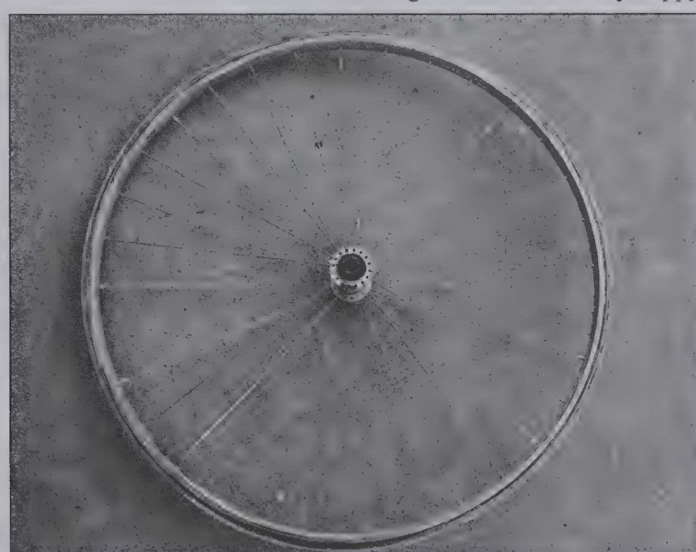


Figure 17—A scrap bicycle rim on its way to becoming a loop antenna. First, remove the hub and all spokes.

Figure 18—Close-up view of the top of the loop and tuning capacitor.

the other day to see an old bicycle wheel rim sitting on the side of the road, waiting to be picked up by the trash man. In true homebrew, do-it-yourself fashion, I decided to take it home and try to figure out what I could build out of it. I did a little research, and found there were a few mentions of people making their own loop antennas with bicycle rims, so I thought I'd build my own.

Figure 19—The finished antenna. The tuning capacitor hangs down from the top and the feed loop is at the bottom.

I first removed the hub and all of the spokes using a screwdriver, which took about 10 minutes; Figure 17 shows it partially done. Next, I took a hacksaw and cut a gap in the rim, which I insulated with a few pieces of electrical tape. Then I drilled two holes, one on either side of that gap, and secured two pieces of 12 AWG electrical wire (scavenged out of some old Romex house wiring cable) with ring terminals, machine screws and nuts, and soldered the wires to either side of an old AM/FM variable capacitor. That all took about 15 minutes. Figure 18 shows detail of the area

Finally, I built a loop (again out of old electrical wire) and attached that to a bit of random coax and a PL259 connector I had lying around, and zip-tied that to my bicycle rim. Voila! An easy, do-it-yourself loop antenna, made out of 100% scavenged parts. Figure 19 shows the end result.

How does it work? So far, on receive only, I've compared the performance of this antenna to my usual arrangement, an off-center fed dipole about 25 feet up, and found that the loop is picking up signals with equal strength on 15 meters. It also works on 20M, albeit with worse reception than my dipole, perhaps due to the height difference. Running the numbers through a handy receiving loop calculator floating out on the Internet from AA5TB, this makes sense—the numbers say this is around 86.52% efficient on 15M, and only around 60% efficient compared with a dipole on 20M. You can see the first receive tests of this antenna on YouTube at

https://www.youtube.com/watch?v=e3_laf7dlo0

Using an SWR analyzer, and after tuning for maximum noise, the antenna reads:

20M 1.4 SWR
15M 1.00 SWR
12M 1.00 SWR
10M 3.5 SWR

I did notice that, as expected for an antenna with a very high Q—i.e. very, very narrow bandwidth—you really have to carefully tune to a specific frequency, otherwise your SWR numbers go through the roof. The calculator says the bandwidth for those bands goes from as little as 5 kHz to at most 60 kHz.

How about using this for transmitting? That's my next step—the limitation on using this for transmitting is actually the voltage rating of the variable capacitor used. Due to high voltage in this circuit, you have to be very, very careful of how much power you put into this antenna or your capacitor may arc. Fortunately for the readers of the *QRP Quarterly*, and this being QRP, it turns out that the approximate maximum wattage my capacitor can handle with its 400 to 500V breakdown matches up to approximately 5 watts. As soon as the bands open I hope to be out there making QRP contacts using the bicycle loop antenna!

—DE KK6FUT
kk6fut@verizon.net

The Fine Print

The usual rules apply; send your ideas and projects to Severn any way you can get it here (e-mail, snail mail, 3 1/2" floppy, CD, handwritten on a napkin, etc), or tell me where you found something of interest on the Internet.

If you have something of interest and aren't sure just where it should go in the *QRP Quarterly*, send it to whichever member of the editorial staff you think is best, and they'll pass it along to someone else as appropriate.

Well written, Pulitzer Prize quality articles are nice, as are computer drawn schematics, but don't worry if you can't do all that. We'll take care of the rest, editing, redrawing, etc. The readers are waiting!

WRITE FOR *QRP QUARTERLY*!

Yes, you can be a published author — we'll help you with all the details.

You only need to tell the story of your project or fun QRP activity, and provide photos and diagrams .

Just send a note to the Editor or an Associate Editor (staff list on page 3).

We're all waiting to see what you have been up to lately...!

Out and About With QRP

Craig Behrens—NM4T craigb44@msn.com

Topics covered: Writing for the QRP Quarterly, *having your unfair-share of fun adventures and a final challenge.*

I have (after much consternation) come to accept the fact that this will be my last Out and About QRP Column. This is the right time to relinquish my space in the *QQ*.

Writing this final column is bittersweet.

There! Having said this, I must now (officially) challenge you, my fellow low-power radio enthusiasts, to actively engage in the myriad of opportunities our magazine offers.

I've known for several quarters this time was approaching and I've wondered how letting go of an activity that has brought me such joy would be possible.

I've had to repeatedly remind myself that relinquishing activities that once were my passion is a natural part of life. Seasons change ...

Immediately, remembrances of times spent with so many friends engaged in worthy adventures flood my mind. Even now, new ideas for getting into more mischief surface, and a big smile appears on my face.

It's been a good run and there will be new opportunities for me to contribute, although in a more modest fashion the next time around. (See Figures 1 thru 5.)

It is hard for me to fathom that I have been intentionally getting into such major QRP mischief and writing about it since the early 1990s.

In retrospect, I decide that I am content, thankful that many such quests have been captured in print. These have become a valued part of my personal legacy.

I predict that you too will discover, as demonstrated in my columns that writing for the *QQ* is a perfect motivational agent for getting you "Out and About."

In doing so, you will discover items of significant interest to share and you will experience many memorable adventures. This must occur so you will have something worth writing about for your next *QQ* submission.

Therefore, your writing will become personally rewarding and valuable.

Besides great adventures, you will find yourself surrounded by the "movers and shakers" in the QRP community. (This is way cool!)

In closing, I must thank QRP ARCI for capturing my/our experiences and for showcasing the practical, often hard-earned, information shared in my past submissions.

I am most thankful for the life-long relationships we have created and will continue to enjoy over the years—I find this to be the most precious of all.

Thanks for all that you do for our hobby and for the benefit of others around the world.

Now, step out and invest some quality time being Radio Active as we make 2016 a great, New Year!

—72, Craig NM4T
The Huntsville QRP Guy
The QRP SkunkWerks

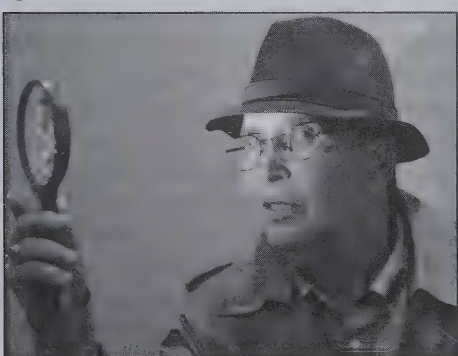


Figure 1—Still some presentations to do.

Figure 2—More car portable locations.

Figure 3—More Monte Sano operations.

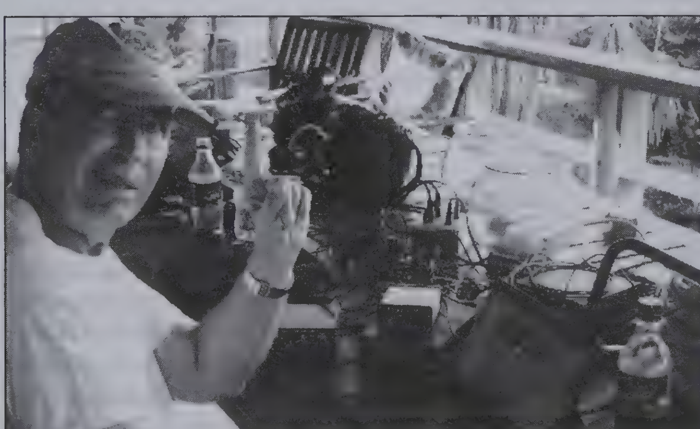


Figure 4—More new technology to leverage.

Figure 5—More time to invest with my special friends.

WebSDR: A Software Defined Receiver Server

James Lynes—KE4MIQ jmlynesjr@gmail.com

Did you ever want to know what your signal sounds like in New Zealand? Then read on...

One Thing Led to Another...

About ten years ago, I was reading about HF beacon transmitters and over the next few days I also came across an article on streaming audio over TCP/IP. Light Bulb! I could remotely locate an HF receiver and stream the received audio over the Internet back to my shack. I thought of this at the time as a reverse beacon. Well, I never got around to implementing this idea but, Pieter Tjerk, PA3FWM, has. He calls his system WebSDR.

Background

In the July 2015 issue of my second favorite magazine, Nuts and Volts, George R. Steber in his article "An Ultra Modern Shortwave Radio", got me started down the road to WebSDR. George introduced the idea of using an inexpensive ($12 USD) DVB-T USB dongle (Photo 1) and a simple 24 MHz upconverter (based on an SA612 with a 3-30 MHz input BPF and output matching network) as an HF receiver. DVB-T (Digital Video Broadcast—Terrestrial) is the EU standard for over the air digital television broadcast. The USB dongle combines a digitally controlled tuner and an ADC. Specifically, the dongle I purchased contains a Rafael Micro

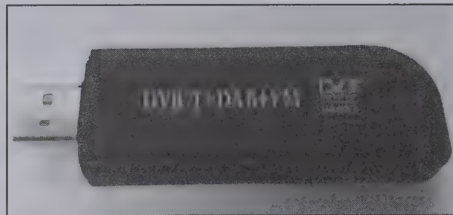


Photo 1—DVB-T USB dongle.

R820T tuner IC and a Realtek RTL2832U ADC. This unit tunes 24-1766 MHz. Other devices are also supported. A Finnish engineering student discovered that a DVB-T dongle could be used in a receiver application and the Open Source Mobile Communication Group(Osmocom) has further developed the concept and provides drivers and utilities.

George's article was based on the SDR# (pronounced SDR sharp) MS-Windows software defined receiver application (sdrsharp.com). If you are a MS-Windows user, I would encourage you to take a look at this package. (The following applications can also be implemented using MS-Windows components, YMMV.)

I am an Ubuntu user (14.04LTS), and was thus out of luck as far as SDR# was concerned. After a little searching, I came across Gqrx (gqrx.dk) developed by Alex Csete, OZ9AEC. Gqrx (Screenshot 1) is based on the GNU-Radio project and the Qt GUI toolkit. I had a false start by installing Gqrx-SDR from the Ubuntu Software Center. This version was old and unstable. After deleting this and installing the most current version, I have been able to listen to WWV at 25 MHz, CB, FM broadcast, Aircraft, 2M, NOAA, 70 cm, and 23 cm. So far 6M and 1.25M have been quiet in my area. My antenna is a 60 foot piece of wire strung through the rafters.

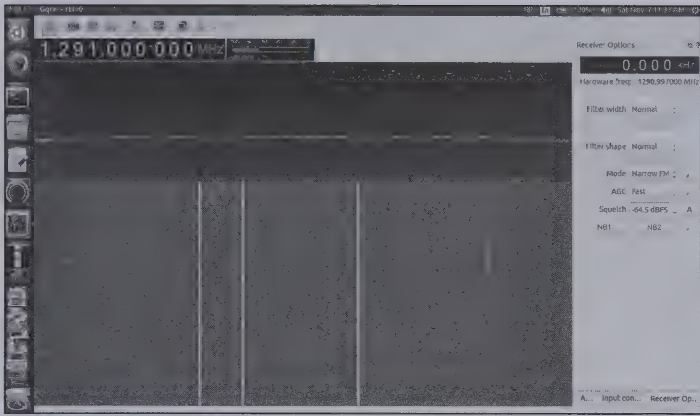
Screenshot 1—Gqrx application.

While waiting on the parts to arrive for construction of the 24 MHz upconverter, my ADHD kicked in. I discovered that Gqrx can be interfaced to Fldigi (www.w1hkj.com & Screenshot 2). I had to give it a try. Every software installation is an adventure (there are no five minute jobs) and this was no exception. Gqrx uses the Linux Pulseaudio feature as a virtual audio cable for distribution of audio to multiple applications. After more head scratching, I discovered that the Pulseaudio Volume Control application is also required but is not installed in the basic Ubuntu distribution. More apt-get install incantations later, Fldigi has audio to munch. I also enjoy playing with Perl and wxPerl (wxWidgets GUI) and I discovered that Gqrx can be remotely controlled via a Telnet connection using a subset of the Rigcontrol protocol. So I threw together a couple of applications (GUI and non-GUI versions) to drive Gqrx like a scanner, running through various frequency ranges (Screenshot 3).

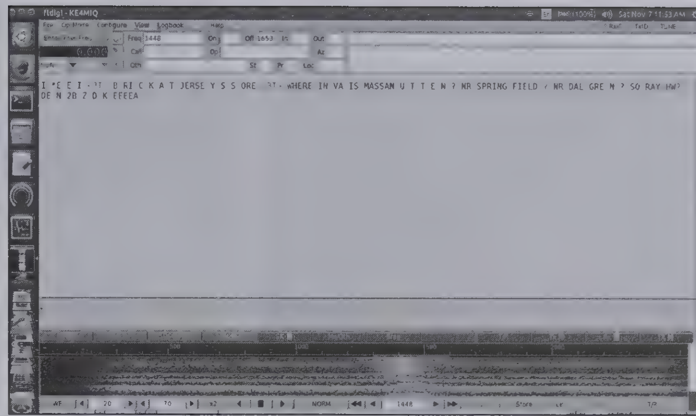
WebSDR

I had never used Fldigi before and I will freely admit that I don't have a clue as to what most of the supported protocols are. While still waiting on parts... I wasn't finding anything to feed to Fldigi. I asked Alex, OZ9AEC for a recommendation on where to look. He pointed me to WebSDR (Screenshot 4).

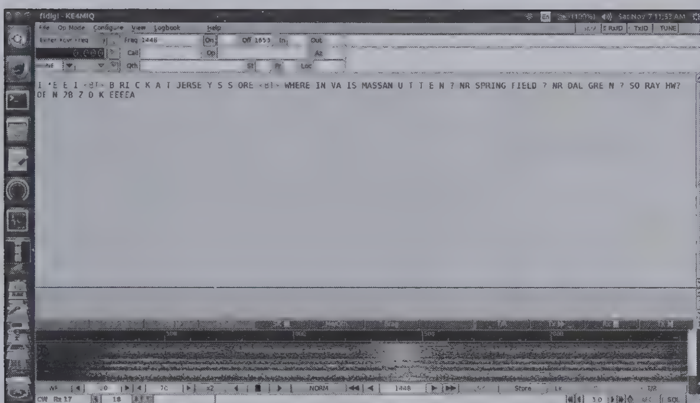
On websdr.org, Pieter, PA3FWM (a professor at the University of Twente in the Netherlands) describes WebSDR as "WebSDR is a software defined radio receiver connected to the Internet, allowing many listeners to listen and tune simultaneously." As of this writing, there are 126 servers located across the globe. Each can support multiple simultaneous users, each tuning independently. The individual server provider determines the frequency



Screenshot 3—wxPerl Gqrx scanner.



Screenshot 4—WebSDR homepage.



Screenshot 2—Fldigi application.

range(s) supported by their servers. The first WebSDR server was developed to provide multiple users access to the 25 meter radio telescope at Dwingeloo for EME reception. While the server software is not strictly open source, it is available via email from Pieter for anyone that has the required hardware and high-speed Internet connection (100 kbps per supported user).

WebSDR is browser based and requires no software to be installed. However, WebSDR does requires a browser that supports HTML5 web audio or Sun's version of Java. Unfortunately for me, Ubuntu ships with open-jdk so I had to install Sun's Java8. Note that Java8 has a new security feature that requires you to use the Java Control Panel(jcontrol) to pre-authorize each WebSDR server that you wish to connect to(probably a good thing).

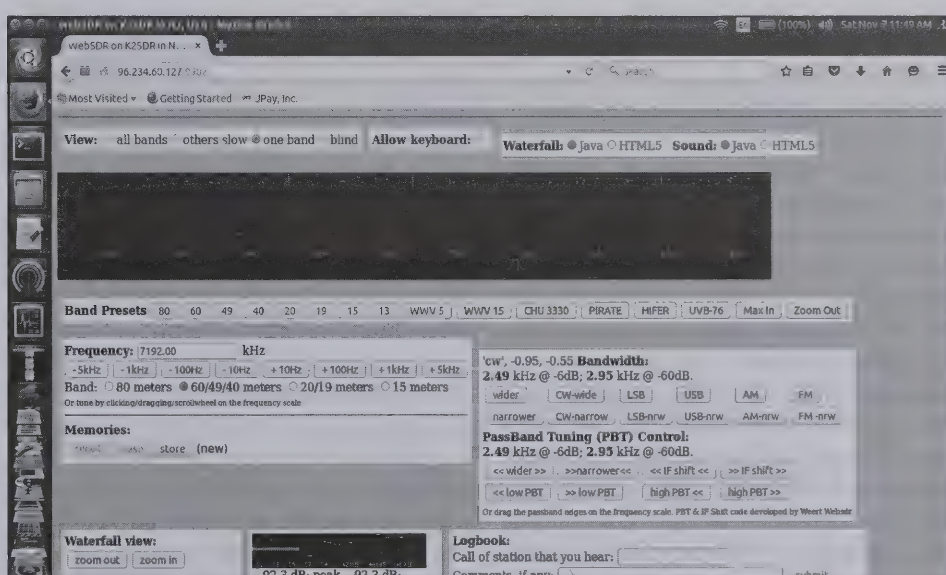
Having now gotten all of my Javas in a row, I selected a server (Screenshot 5) provided by K2SDR located in New Jersey (I am in Florida). It happened to be the weekend of the CQWW SSB contest and the screen was alive with SSB Salmon jumping up the waterfall. Stations were heard from the US, Canada, EU, Russia, South America, and the Caribbean. CW and PSK-31 signals were located and fed to Fldigi for decoding. Success!

As open source, WebSDR is open for customization by the server provider, so the look and feel may vary between sites. In general you will see a waterfall display, band select buttons, demodulator select buttons, filter width controls, waterfall controls, etc.

So, if you would like to explore SDR at a great price (free), or actually want to hear what your signal sounds like in New Zealand, check out WebSDR. And thank you for sticking with me through this rambling episode of "Short Attention Span Theater".

References

websdr.org – Home to the WebSDR application
sdrsharp.com – Home of the SDR# application
gqrx.dk – Home to the Gqrx SDR application
groups.google.com/forum/#!forum/gqrx – Help for Gqrx
rtl-sdr.com, rtlsdr.org – Info on DVB-T dongles
w1hkj.com – Home to Fldigi
nutsvolts.com – Nuts and Volts Magazine Homepage
sudo apt-add-repository ppa:gqrx/ snapshots – current version of gqrx



Screenshot 5—WebSDR K2SDR server.

OCF-On-A-Stick: A Multi-Band Portable Antenna

Ben Kuo—KK6FUT kk6fut@verizon.net

One of the great joys of amateur radio for me—and many other amateurs—is the ability to operate their radio almost from anywhere, including out on a mountain top, in a field, at a park, or at the beach. However, operating portable has always had its set of challenges, not the least of which being the ability to transport and set up an antenna. In particular, around my QTH in Southern California—as well as many other parts of the world—it's tough to find a decent tree which you might be able to string up a dipole, and even in areas where you can find a tree, it's a huge amount of work to get your line up there high enough to make it work.

To that end, a lot of amateurs have turned to stand-alone, portable antennas, with probably the most popular today being the commercial Buddipole™, and Buddistick™. For those not familiar with the designs, there are actually the commercial versions of these two antennas, as well as published designs you can build yourself from W3FF (Budd Drummond), the inventor of the Buddipole. W3FF's designs, which any homebrewer can build, were eventually turned into those popular designs, but are constructed out of PVC pipe and speaker wire. The commercially available Buddipole and Buddistick are extremely popular with portable operators, and I have had great success operating with W3FF's homebrew version, which I built myself as my first portable antenna.

The Buddistick, the vertical version of Budd's antenna, works by using a loading coil and a short whip, which is matched to a counterpoise wire, which is adjusted in conjunction with the coils to the length to match the band you wish to operate on. If you want to switch a band, it requires adjusting your tap point on that loading coil to the appropriate spot, and extending or retrieving the counterpoise line to the appropriate length. Essentially, you are working with a coil loaded dipole in vertical position, which is adjusted for every band. This works great, except, as many operators find, it can be very, very, very difficult to adjust the antenna to resonance. Most operators of these designs—after thrashing about in the field and getting high SWR readings from their radios—end up packing an antenna analyzer with them, to more finely tune the length and coil tap locations.

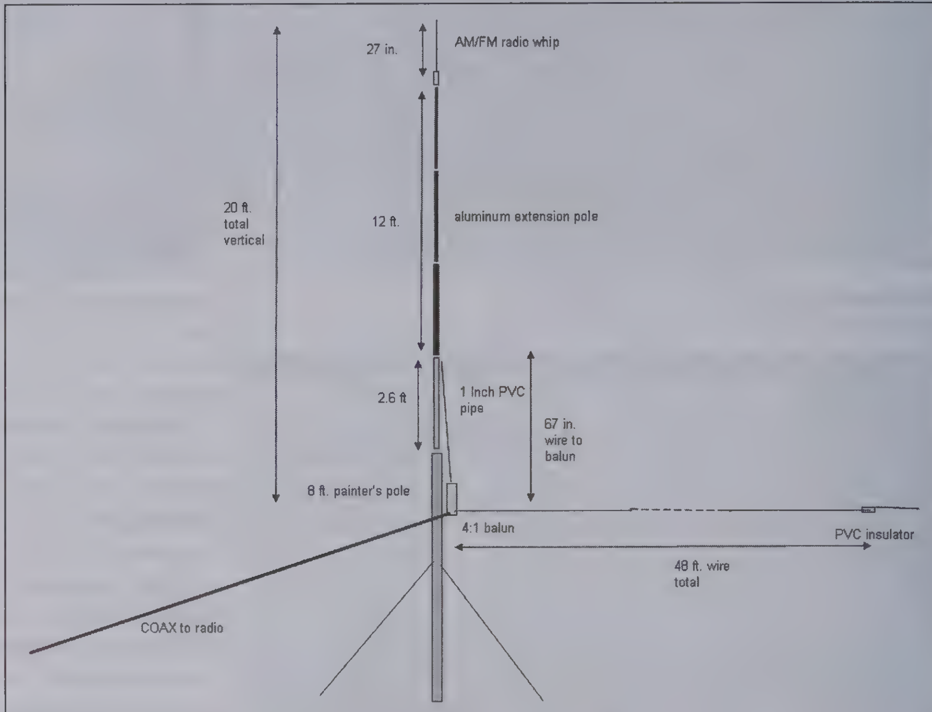


Figure 1—Details of the OCF-On-A-Stick construction.

I've found, in personal operation, that makes it very impractical to use the Buddistick for switching bands, and it's always very cumbersome to set up quickly. Usually, it takes me 20-30 minutes to set up and get it all tuned correctly, it's another 10-15 minutes of futzing around when every time you switch a band, which is non ideal if you're just hoping to tune around to another band for a quick contact. I've always wished there was another version of this design which eliminated having to reconfigure and tune the antenna every time you want to switch bands.

Enter the OCF Dipole

Enter the OCF (off center fed) dipole—also sometimes known as the Windom, depending on whose version you are looking at—which I have been running with great success at my home QTH. Although it may not be the most efficient on every band, I've found that the OCF has been my go-to-antenna, and I've managed a significant amount of DX on the OCF, even just mounted 25 feet up on the side of my house. I've also managed to run this in the field (when there have actually been trees) and gotten some serious, globe-reaching contact on it (in particular, 10m contacts all the way from California to Borneo and China on 100W). With a tuner, you can work pretty much every band, from 80m to 2m (there's a version out there for 160m as well). SWR is pretty much <3, and usually around 1.5 for most bands. With my old, hybrid and tube radios at home, I actually do not end up having to use a tuner at all, as the matching networks on those radios easily match the impedance of the OCF. I've been very happy with this antenna. I've even used this portable, however, it suffers—like all dipoles—when you want to hoist it up where there are no trees (unusable); and even if you do have a tree available, I've found getting your dipole up high enough is a huge chore.

That said, the OCF's multi-band capability without having to physically adjust the antenna is a blessing, and one I wished I could replicate in a portable antenna (particularly, every time I pulled out the Buddipole and spent 30 minutes futzing

Figure 2—The prototype antenna installed at a park for testing.

Figure 3—The W4INF design 4:1 balun.

Figure 4—A better view of the antenna, to show the section joints.

with the counterpoise to get things to resonate anywhere less than an SWR of 3.0!!)

The Aha Moment

I've been running the Buddipole/ Buddistick for a number of years, and the OCF at the same time at my QTH, but it was only a short time ago—as I was figuring out how to support a field deployment (Boy-Scout Jamboree-On-The-Air) with a self supporting antenna, and grumbling about how much I HATE trying to tune the homebrew Buddistick vertical I built during portable operation—I had a epiphany! Why not put an OCF dipole and run it like the Buddistick? I don't know why I didn't think of it sooner, and I was surprised when I couldn't find someone out there that had done this (if they have, looking all over Google apparently didn't find me an example.) So, I built a prototype of an OCF in the form of what a Buddistick might look like, with a vertical radiator and counterpoise—but instead of using loading coils and an adjustable counterpoise, I just used the short end of the OCF for the vertical, added the standard 4:1 balun at the feedpint used in the OCF dipole, and used the long end of the OCF for the counterpoise, about 5 feet off the ground.

I used one of the dimensions of the OCFs out there as a starting point, with the short side (20 ft) as the vertical, and using the long side (48 ft) off the ground. There are multiple variations out there designed to match better to different bands with different short and long sides, but I went with one of the designs I know some radio club members had had success with in my area as a first try.

The Prototype OCF-On-A-Stick

To construct the first prototype of the OCF-On-A-Stick, I decided to use what parts I happened to have on hand in the ham shack. It was pretty easy to get the counterpoise wire done. I used standard, stranded #12 copper electrical wire which I have lying around on a spool for projects. For the vertical, instead of using copper wire, I happened to have an old AM/FM antenna, 29 inches long, from a salvaged AM/FM radio, plus a 12 foot aluminum extension pole I had pulled out of a trash dumpster earlier this year. Finally, I already an eight foot, painter's pole which I had used with my original build of W3FF's Buddipole/Buddistick, which I recycled for use in this project, as I already had it rigged for quick connections of tiedowns in the field, along with a few camping stakes. Finally, I used some PVC piping for connecting the various parts together. A diagram of my first prototype is in Figure 1, and a photo of one of the prototypes of the antenna set up in a park is in Figure 2. (see below for notes on the antenna in Figure 2, which has some duct tape repairs).

For the 4:1 balun, I used the voltage balun described by W4INF on the web, which I have had success with in the past, and which (for the cheapskate ham that I am) only requires the use of some wire, 1 inch PVC pipe, and a drill. (You can find W4INF's design at RogerTango.com). Photo of the W4INF balun in Figure 3.

For the vertical section of the antenna, I first extended the 12 foot aluminum extension pole, and drilled holes near the edges of each segment. The reason for this, is I discovered there as no electrical contact between the individual aluminum extension segments. With some wire and screws and appropriate connectors, I was able to make firm contact between the sections. As this is the prototype, I did not worry about how fast I could assemble this, but for true portable use, an aluminum extension pole may not be the easiest

Band	VSWR
40m	3.0
30m	1.1
20m	1.2
15m	2.0
12m	1.3
10m	3.6

Figure 5—SWR analyzer results. The match is usable on six bands.

Band	dBi
40m	–0.24 dBi
30m	1.57 dBi
20m	2.48 dBi
15m	3.36 dBi
12m	3.33 dBi
10m	5.5 dBi

Figure 6—Maximum gain for the OCF-On-A-Stick according to EZNEC.

material due to having to use six screws up and down the extension pole at your site. For a future version, I foresee using some kind of quick connector (PowerPole, etc.) and PVC pipe segments, ala W3FF's original Buddistick design, where one can easily snap segments together to the proper height without a screwdriver. A photo of the aluminum extension connections is in Figure 4.

At the top of the aluminum extension pole segment, I used a AM/FM antenna whip. I'm unsure, electrically, if it makes a difference to the antenna, but it does make extending the antenna size much easier and lighter than another segment of PVC or other material. This was connected with the top of a broken sprinkler head (cheapskate showing again) to the top of the pole.

On the bottom side of the aluminum extension pole, I used a segment of 1 inch PVC, which happens to allow the aluminum extension pole handle to nest nicely inside, keeping it secure; I adapted another screw-on sprinkler head attachment to allow this PVC to connect to my painter's pole, which makes up the base.

Finally, for the painter's pole, I have three supports tied to tent poles (with a taut line hitch on each paracord support), which keeps the entire thing upright. For convenience, I had used some zip ties in place so I did not have to tie the requisite knots every time I go out in the field. There are many different options for these supports.

But, How Does It Work?

The ultimate test of an antenna is, how does it work in real life? Connected to 50 feet of 50 ohm coax, and placed on my back lawn, these are the SWR readings I got (with no tuner attached). Amazingly, based on the SWR readings, the OCF-On-A-Stick works passably on six bands—10m through 40m, excluding 17m—within the bounds of most typical antenna tuners.

Although the SWR reads fairly low on 80m, I've chosen not to run on 80m due to the overall length of the antenna, and some dodgy real world RF-in-the-radio issues I found in testing, which was also the case with 17m. On 17m, the SWR readings are low, but actual usage resulted in wildly swinging SWR on my transceiver.

So, it actually still tunes on almost every band I might be interested in working, after setting up the antenna for testing, I was immediately able to make both local and distant contacts, despite poor band conditions! As I get time, I plan on doing more testing of this antenna on the bands and see how far I can get.

Your exact mileage on this antenna will also depend on the length of the coax used to feed the antenna, which also might affect how it tunes on different bands. I used this antenna across all the bands listed below in a local contact across town, and spent a day making contacts on multiple bands during the California QSO Party, mostly with stations across the U.S. and Canada, and deployed this antenna in a park for a day for the annual Boy Scout Jamboree-On-The-Air (JOTA) in October, where our farthest contact was to Japan, 5580.4 miles away, on 15m phone. We also made many contacts also on 20m and 10m. Interestingly enough, for the Boy Scout JOTA, we also put up an identical OCF dipole in a more standard, inverted V in a tree, and found that we were unable to use 15 meters on that OCF, but able to work 17m, even though the dimensions of both the long and short sides of the OCF were identical to the OCF-on-a-stick—perhaps due to the dramatic difference in coax length on the two antennas.

An Amateur Antenna Analysis

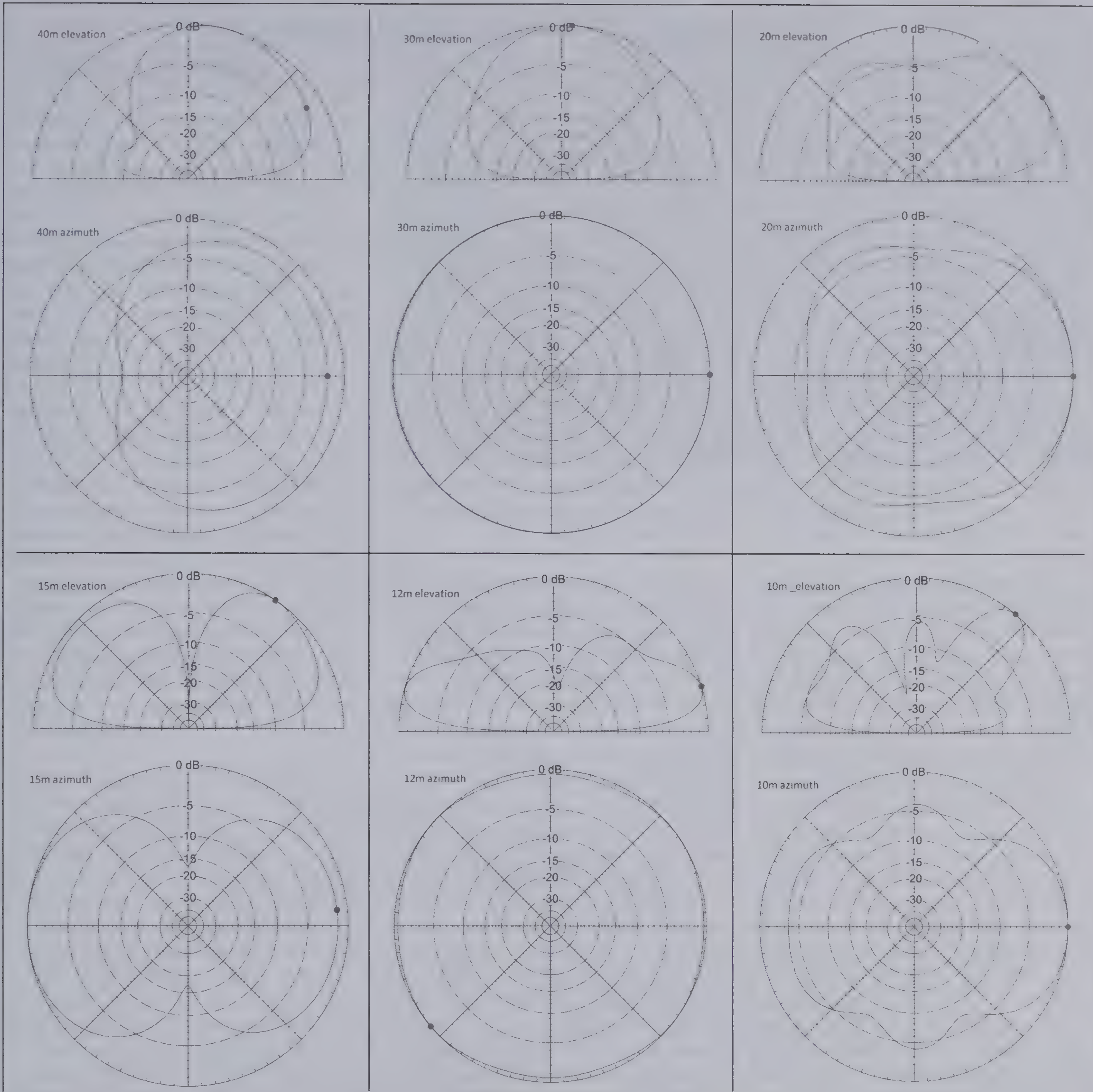
After testing out the antenna, I was curious to what the antenna field would look like when run through a computer analysis, and a couple of wise Elmers suggested I try out running EZNEC and see what the result was. Here is the result of my analysis on this antenna, with the caveat that OCF antennas (apparently) are very difficult to model given the tendency to use some of the feedline as antenna, and the use of a balun at the feedpoint. I've also used the (less capable) EZNEC demo version, which was non ideal. I'd welcome any reader input or attempts to better analyze this antenna design.

This analysis reflects how the prototype was built, with the long leg 5 feet above ground. It resulted an interesting distribution of gain numbers (Fig. 6). Remembering that the gain of a dipole is 2.15 dBi, we see that the 20m, 30m, , 15m, 12m, and 10m (theoretically) all actually end up with a higher gain than a standard, reference dipole. 30m and 40m are worse, with 40m significantly worse.

In terms of radiation patterns, almost all of the patterns show more gain on the long side of the antenna, in the direction of the long counterpoise length, with the exception of 30m, where the pattern looks to be almost entirely circular (both in azimuth and elevation plots).

40m looks like a fairly directional antenna towards the counterpoise, 20m is still directional with a lot of the energy at a fairly low angle of radiation, and 12m has a very strong, low angle of radiation.

One interesting thing which turns up in the antenna analysis, is if you raise the endpoint of the long leg of the antenna (the counterpoise) higher, you see that you get a corresponding efficiency and increase in gain for the antenna, as you might expect. One experiment might be to raise up that counterpoise as high as practical in portable operation in order to maximize of efficiency of radiation from the antenna. I've found, however, that in portable operation it's always a tradeoff in ease of setup versus efficiency of the antenna; in many, many areas (for example, mountain top operation or on a beach) there just aren't that many places you can secure your counterpoise to, except maybe a low bush, your trekking pole, or a beach umbrella! However, there might be an application here of this antenna configuration as a no-tune vertical at your home station, where it may pay to put your feedpoint up as high as possible—or maybe even use the long side as your radiator,



Antenna pattern plots (EZNEC) for the bands of operation.

and your short side of the antenna as your ground radial.

What's Next?

Given the experience with the prototype of this antenna, as well as the result of the analysis, some of my next steps with this experimental antenna include:

1. Further testing in the field.
2. Optimize the construction for easier field assembly (PVC + speaker wire?)
3. Variation on short/long leg ratio to better tune SWR
4. Modification of the height of the long leg of the antenna (higher) to see if that improves or changes the overall gain on the antenna

Summary

In this article, I've described a new trick for an old antenna (the OCF dipole), which I believe might offer up a better solution than the current, Buddistick commercial antennas, by allowing for less hassle with the antenna, better SWR without the need for a tuner, easier adjustment when switching bands, and simple, homebrew construction. Hopefully, this article might help to inspire other amateurs to experiment with their own, portable antennas—and perhaps, evolve a better solution for a multi-band, portable antenna. ●●

The 1Watter Transceiver: A Review

Chuck Adams—K7QO chuck.adams.k7qo@gmail.com

Every year I teach a code course to 30 to 35 individuals for the local radio club that I belong to. I was not satisfied with any code practice oscillator that uses a NE555. The tone is not pleasant to listen to and causes fatigue rapidly for the student. This for live practice during the class once a week. I was also interested in the possibility of using a QRPp XCVR that was economical.

The goal was to find a CPO or XCVR that was not a budget breaker and one that was reasonably priced for the performance offered. I personally purchased all the QRPp transceivers I could find, both domestic and foreign. I was, for various reasons, not completely satisfied. So I started touching base with people that I thought could help.

I contacted Diz Gentzow, W8DIZ and QRP Hall of Fame member, via email with information about what I was looking for. Within a day or two he came up with the transceiver named the “1Watter”. It was designed for an optimal operation at 1W output. The price point was 50 dollars and could be used as a CPO and as a transceiver. I look at this as a positive for a number of reasons:

One—Instructors can teach the student to send, using either a straight key or a paddle, as the transceiver has a built in keyer and will operate in a straight key mode for use with a J-38 or equivalent key.

Two—We also can teach students to build a kit on the side and they have a QRPp rig that is small and useable. I have a technique for building an enclosure for $2 and plan on charging the student only the $2 that it cost me to make. It only takes about 30 minutes per enclosure and the exercise is optional. I don’t expect every one to want to do this.

Three—As an instructor, I can buy two transceivers and in class have the students send to each other and later learn to send a CQ and then respond and carry on a QSO. Using something like a dummy load for 15 bucks from qrpkits.com, which is what I call a “leaky dummy load” in that it radiates and can be heard within a room easily by another receiver, QSOs and pileups can be simulated by any number of transceivers powered up at the same time.

I know. You want to get on me about putting a possible beginner in a difficult situation by building their own XCVR and using QRPp levels. Don’t look at the negative. We have to train new and old hams on this part of the hobby, whether it is difficult or easy. This is not a spectator sport. Train them and they will come. Otherwise you are killing the hobby. How many have you trained this year? Consider it a challenge.

This article is a review of 1Watter transceiver. This article is not intended to be complete nor go into all the details. That is left as an exercise for you. I am limited in the space that I can use and the time.

For a starting point, the web page is http://www.kitsandparts.com/ The web page for each 1W for each band can be found from one of the links on the left hand side of the home page.

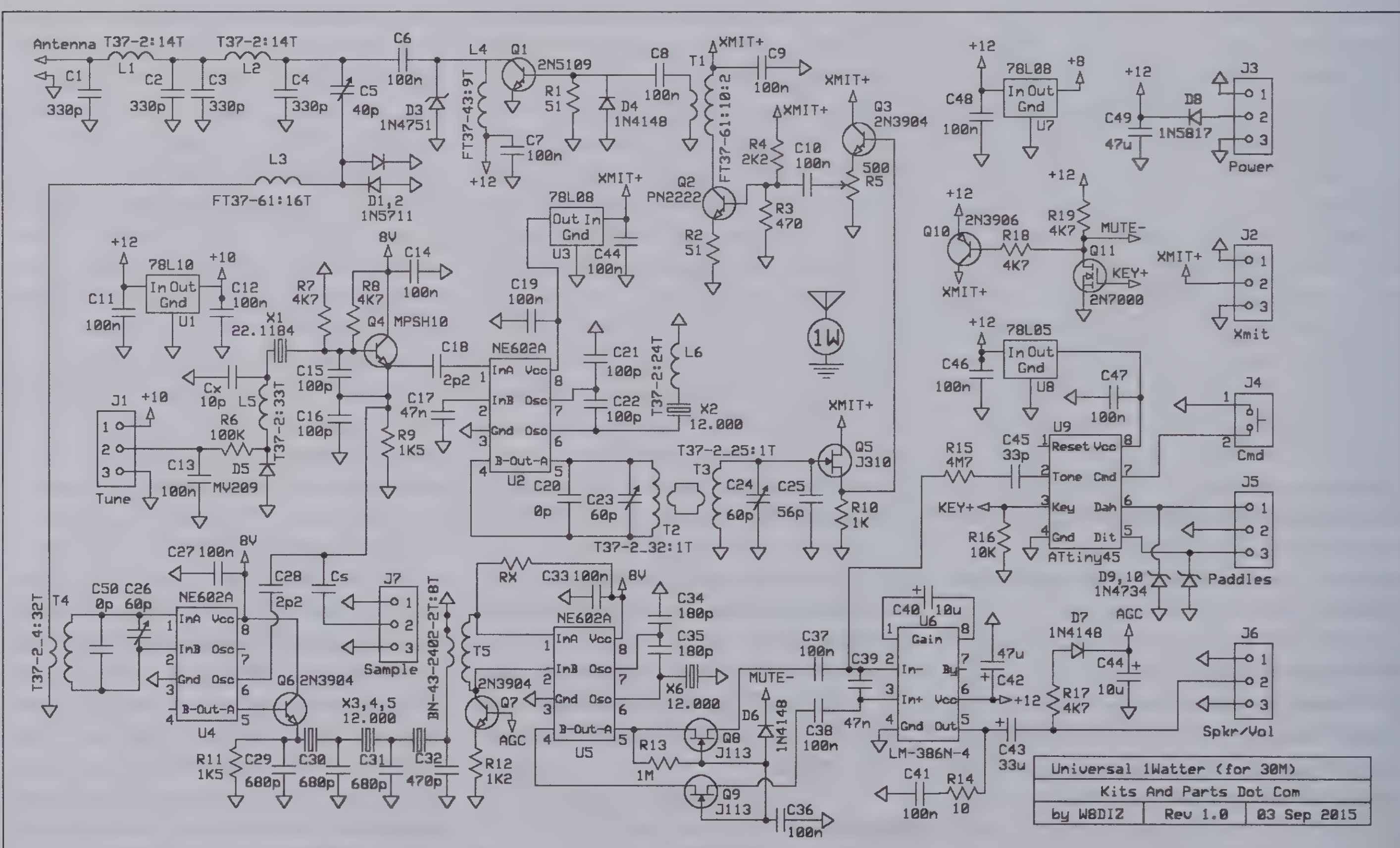


Figure 1—Schematic diagram of the 1Watter transceiver.

There is also an email group for 1W owners and interested parties. See http://www.kitsandparts.com/1watters.com/ for the page to get started. We use this group to communicate band conditions and for spotting each other and bragging about DX worked or the number of states racked up in a days work.

And there is http://www.k7qo.net/onewatter.html/ for my work in writing a step-by-step assembly and test procedure for those that want to build and test each section to keep from having to debug the entire transceiver after completion of assembly.

Specs

The official name of the transceiver is "The One Watter" or "1Watter". On the air, a number of us have been using "1W20" for the 20 meter version. This to prevent confusion when saying the rig here is 1W and the power is 1W. At the time of this writing, it was the only one on the air except for two 1W30's owned by W8DIZ and K7QO. Since there was a delay in getting the article into print, there are now 1W transceivers on all bands from 160m to 10m and a rumor of 6m to follow. Here are the specifications:

PWR: 1W out with 12 VDC power supply
BANDS: 10-160m
TUNE: VXO for the VFO, see below for bandspreads on each band
RCVR: Dual conversion superhet. Based on the NE602. Very quiet with a measured MDS of –137 dBm done by Dale, W4OP. And I trust his measurement. See below. It also has audio derived AGC. For the price, you can not expect DSP features. This AGC has saved my ears numerous times as I will discuss later. It has a 3 pole crystal IF filter that is about 400-450 Hz wide and has fantastic opposite sideband rejection.
XMTR: 1W output with a 2N5109 final PA transistor.
PCB SIZE: 3.8" x 2.5" or 96.5mm x 63.5mm.
ENCLOSURE: Provided by the builder.
CURRENT DRAW: Between 34 mA and 35 mA on receive with the audio gain at the minimum. 250 mA on transmit with 1W output into a dummy load. This should make it battery friendly. The tune pot was 10K and took up 1 mA of this. If you use a 1K linear pot, then figure 10 mA for that alone as the voltage regulator for the bias on the varactor diode is 10V.

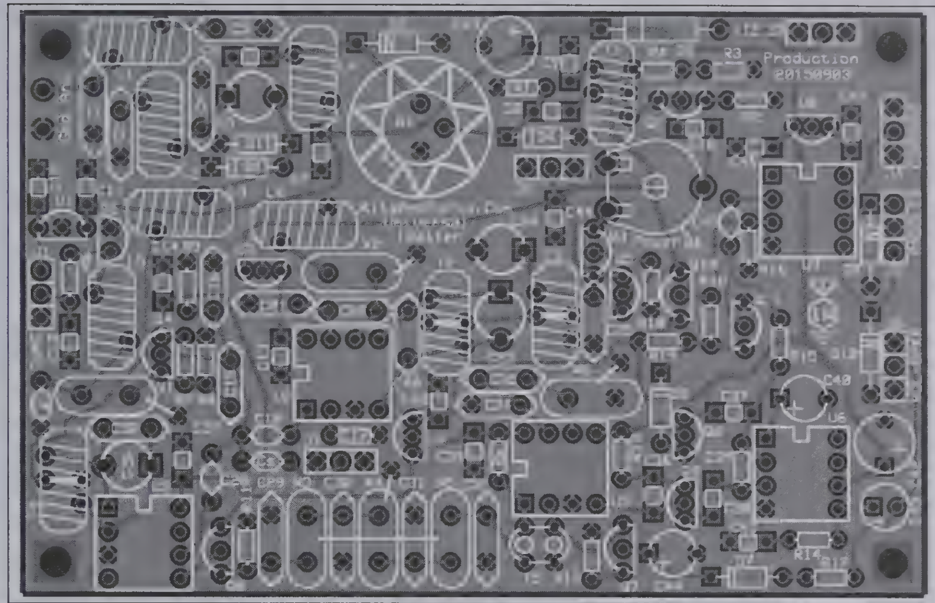


Figure 2—The unbuilt printed circuit board for the 1Watter. You can see the compact layout with a mix of SMT and through-hole components.

The Kit

The kit comes to you for the price of around $50 with all the parts for the PCB and connectors except for the tuning pot and connecting wires needed from the PCB to the connectors and control pots. The kit includes all the connectors for the speaker/headpones, the paddle or key, a BNC connector for the antenna, DC barrel connector for power, a push button for the keyer command button and the audio gain pot. You supply a 10K to 100K linear pot for the tuning. This allows you to use a 10-turn pot if you are so inclined. You also supply the wires for connections. I used #22 teflon coated stranded wire. You will also need a linear 10K pot for the keyer speed control or you can use the command mode using the dual lever paddle.

There is an VXO frequency output terminal to add something like the freq mite audio annunciator that the 4SQR group has on their web site or you can use one of the Chinese LCD counters for a display of the frequency using an IF offset. And for the true homebuilder you can add a frequency counter of your own choosing.

The components are of excellent quality. Uses 1/8W resistors mounted flat on the PCB. There are some toroids to wind for inductors and also for transformers, but Diz has detailed online information and photos to aid the builder.

The only SMT components are the 100 nF (0.1 uF) bypass caps (about 20) and they are the larger 1206 size. These are all mounted first so that when the board gets crowded there is no difficulty in installing them. Hopefully this is not a turn off for any builder. There are holes in the PCB so that you can install 100 nF disc or mono caps that you provide. This is what I did, not because I'm scared of SMT, but I have thousands of these that I am trying to use up before the estate sale comes along.

Schematic

Figure 1 is the schematic for the transceiver. Shown is the 160m version 2 and there will be a different schematic for each band available on the website at kitsandparts.com.

PCB Layout

The PCB layout of an early release of the transceiver is shown in Figure 2. The latest revision will always be available on the web site for the kit.

Receiver

I find the receiver to be of great value for the $46-50 price of the transceiver. I'm not expecting a Yaesu or ICOM or even Elecraft performance figure, but it is a very

nice piece of work for the price.

It is quiet. The noise level of the receiver is appreciably lower than the noise level of the band being used. Dale, W4OP, measured the MDS at –137 dBm and I believe that measurement after having used the XCVR for over 45 days on 20m. I also built a S9/S1 signal generator modeled after the NorCal early kit version and I also measured the MDS at –137 dBm.

The bandwidth is about 450 Hz to 500 Hz at the –3 dB points for 20m. Other bands will have to be measured as they come out in kit form. I find the selectivity to be very good for CW work. s the rig has great sensitivity, you will find some QRO signals that will be heard over a larger range, but that is something that I can live with. Remember the price we paid for the transceiver.

I have worked GA and MDC at times when the propagation was not all that great and the signal was just at or just above the noise level. On 20m, you have the problem with QSB, so QRP and QRPp signals can be challenging, but isn't that part of the game. I always wonder about the people that spend thousands of dollars to get receivers with MDS at or below –125 dBM, but then turn around tell me that they refuse to work QRPers. Why did you spend that much money and not even want to work weak stations? Seems silly to me. What if I got to get a lifetime opportunity to activate North Korea and I took a 1W with a dipole? Bet you I'd get some interest in working weak signals. Guaranteed.

I can hear, on many nights, VK and ZL signals and can raise a QRZ? from them with the 1W using the dipole discussed later. I will work a few of them before the year is over. just have to get the band in a good state. Too many CMEs and X-flares of late with geomagnetic storms also.

Band	Operating Range	VXO	IF
10 meters	28,052 – 28,061 kHz	20 MHz	8.064 MHz
12 meters	(not designed yet)		
15 meters	21,056 – 21,061 kHz	13 MHz	8.064 MHz
17 meters	18,069 – 18,087 kHz	22.118 MHz	4.032 MHz
20 meters	14,056 – 14,061 kHz	8.064 MHz	6.000 MHz
30 meters	10,101 – 10,119 kHz	22.118 MHz	12.000 MHz
40 meters	7,020 – 7,040 kHz	23.04 MHz	16.000 MHz
80 meters	3.557 – 3,562 kHz	13.56 MHz	10.000 MHz
160 meters	1,805 – 1,812 kHz	8.192 MHz	10.000 MHz

Table 1—Tuning ranges, VXO and IF frequencies for the 1Watter.

Tuning Ranges

The tuning ranges for the each of the bands are shown in Table 1. These are subject to change as the transceiver kit comes out for each band and some ranges are dependent upon the builders selection of inductance and capacitance values chosen for the VXO (variable crystal oscillator).

A personal note. I find the range, say for 20m, just fine. This is not a DDS controlled transceiver. I don't like to get too far from the QRP calling frequencies anyway. I will miss activities in the lower part of the bands, but that is not an issue with me. I'd move to a more expensive rig if there is something that I just gotta have. Because of the selectivity you do not want a fast tuning rate as you will miss signals in tuning from one end to the other on the dial. In using the 20m version, I have coverage of the QRP frequencies, the FISTS CW club, the county hunters and a large number of the Straight Key Century Club (SKCC) members.

I highly recommend that you get a SKCC number. I have gotten a large number of states at 0.95 W, the power output that I set the 1W20 for, by having the number and working some of their sprints. And they are using straight keys and their code speed is not going to be threatening. Good practice, if you are rusty or haven't been on in some time..

At the time of this writing I have 40 states and 8 countries. Even picked up Sweden late one night when every one has gone to bed after they thought the band was dead. Since I am at a new QTH, my goal is to get 50 states on as many bands as possible at 1W or less.

Transmitter

The transmitter is designed for 1W output and the output level is super stable. In fact, it does something that a lot of transceivers can not survive. You can key the transmitter without a connected antenna or a dead short across the BNC connector and the final PA will still be functioning. I have personally, in many decades of QRP and QRPp operation, lost a number of final PA transistors by making a mistake when powered up and keying the transmitter.

There is an capacitor that you can substitute a smaller value to have true QSK operation. The later versions, V2, of the transceiver allow for monitoring of the RF out for the sidetone and you will want to go to full QSK operation, if you are like me. Some operators still don't want full QSK and that is the standard default value of the capacitor, as mentioned in the build instructions on kitsandparts.com web pages.

If you operate the receiver with the audio gain high, you will get some thumping in the speaker or headphones caused by the uP keying sidetone and the AGC interacting. I avoid this by using my normal operating mode of having the audio level set as low as I can for operation. This to protect my hearing over my lifetime. So far it is working. The newer version with the transmit sidetone eliminates the minor effect.

The keying is very nice and working other 1W transceivers is a pleasure and nice to hear clean keying. But that is typical of a lot of transceivers in the modern age.

The transceiver is designed for 12 VDC operation and can easily be powered with a gel-cell, which I use and is recharged when not in use by a cheap Harbor Freight 5W solar cell.

QRPp Levels of Operation

When operating at QRPp levels, some things become more important and critical than at QRP or QRO levels.

Spend all the time and money you can afford on the antenna situation. All the energy at the antenna connection must be radiated to be effective. Any losses decrease you chances of success at communications on any band.

I live in a gated community with HOA regulations that make an attorney cringe. I got around the situation by being nice to the powers that be. I went into the HOA

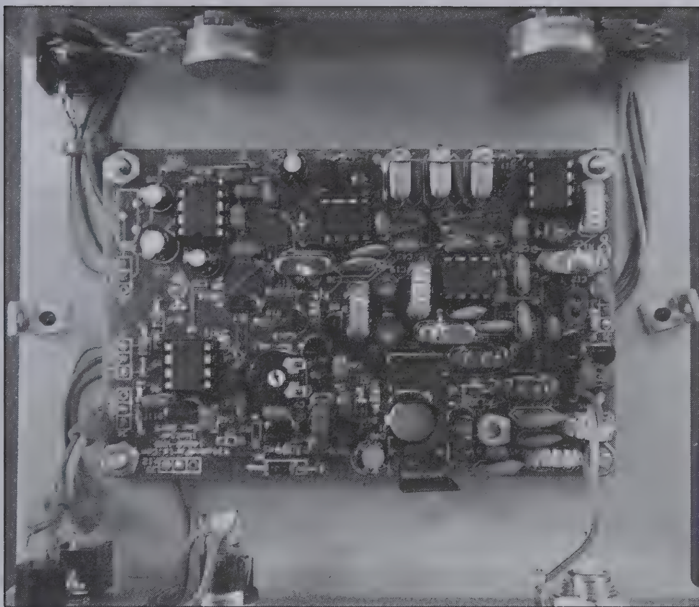


Figure 3—1W in TenTec TP-19 enclosure.

Figure 6—20m dipole 7m high, using MFJ mobile whips.

office and told them that I had an antenna that was not a permanent structure that I would have up only when I was using it. They gladly gave me a permit to use same.

My antenna consists of a 7m pole that was/is manufactured in Germany and a dipole. I bought the pole from Vern Wright, W6MMA, now a silent key but had an antenna company that had the pole and two element portable beams. I also have a beam.

The pole is made up of 5 sections that push up and lock in place with a rotating screw collar that clamps the section and produces enough friction to hold the section in place. Goes up in a matter of 30 seconds or so and down in less time.

The dipole consists of a fixture to hold two mobile whips in a horizontal position opposite of each other. MFJ has one model number MFJ-437 and runs about $20. Two MFJ mobile Hamtennas are $14.95 each in the online catalog and HRO charges $16.95 each for them. It is this antenna that I was using the first 45 days to get the 4 countries and 28 states on 20m.

Figure 4—1W with S/N 54 in TP-19 enclosure.

I have started using an end fed half wave (EFHW) wire antenna to determine how much difference there is going to be between the two antennas for the purpose of seeing if the EFHW will be useful for SOTA trips.

Here are some tricks to do QRPp well, in my humble opinion:

1. Don't call CQ at more than 20 WPM. In fact, I get more SKCC guys to come back to me at 17 WPM down to 15 WPM. Remember they are using a straight key. Speed is not the goal here, the number of contacts is. There are nearly 14,400 members within the SKCC group. That has to be the largest group around that I know of.

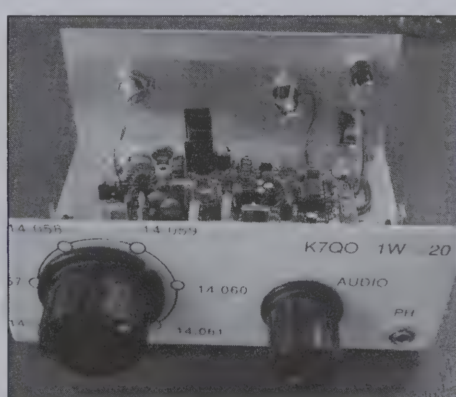


Figure 5—1W S/N 2 in homebrew enclosure.

2. Don't be afraid to call CQ at any time of the day or night. I have tuned the 7 kHz range on 20m and not heard a peep. I've called CQ and immediately gotten a response.

3. Listen for the weak stations and don't be afraid to call them. That's why you have a sensitive receiver. A lot of them may be other QRPp stations just like you.

4. Consider leaving the transceiver on while using some powered PC speakers while doing something else in the shack or work area. The band may open up or may you hear a familiar call sign to work again.

And there are any number of other helpful hints, but just get on the air. The bands get lonely without you.

Conclusion

I think those wanting a QRPp transceiver that will not break the budget, but still give excellent performance for the cost, the 1W from Kits and Parts will be a great bargain. But then, I may be biased slightly, because I love the challenge that QRPp operation has. I had been QRT for over a decade and this transceiver has gotten me back on the air daily. I hope to work you on the bands with the same transceiver.

Photos

Figure 3-6 are some photos of the transceiver in an enclosure and the antenna system, to reinforce the descriptions in the article.

A Parallel IF Board for the LBS Transceiver

Dr. Paul Darlington—MØXPD paul@appledynamics.com

Ben, KK6FUT and Pete, N6QW have described in these pages a complete HF transceiver system [1, 2] which has now been duplicated by many builders, proving that the authors succeeded in their call, "Let's Build Something". This article describes an addition to the LBS range, which extends the original project in three dimensions.

Firstly, the small project in the present article introduces an alternative to the relay switching used in the remainder of the LBS transceiver. Transmit/Receive switching for the bilateral amplifiers is implemented using an electronic switching scheme based around FETs. This makes the board fast to operate, amenable to electronic control from a microcontroller and simplifies wiring when the new module is wired into an existing transceiver. The design—including the electronic switching scheme—is 100% compatible with the existing LBS modules and is easy to integrate into other applications.

Secondly, the new module extends the construction methods used in the LBS series. Whilst N6QW has described the application of surface mount technologies to the LBS transceiver [3], this project embraces a Printed Circuit Board design for one of the modules. The printed circuit has been designed for leaded, through-hole components, although a surface-mount alternative certainly is possible. Specifically, the "Crystal Filter and Bilateral Amplifier" circuits in Figure 7 of [2] are implemented on a PCB design, to produce a replacement module for a part of the LBS transceiver. The open-source design of the PCB is presented in this article (electronic copies are available from the author), allowing new and experienced builders alike to experiment with building on a printed circuit board. The design intentionally uses leaded components which are mounted 'through-hole' in a single-sided printed circuit board, which can easily be fabricated at home.

Thirdly and most importantly, the system implements a "Parallel IF" scheme, as described in [4 & 5]. This introduces a pair of parallel crystal IF filters, having different passband frequencies and different bandwidths. By appropriate choice of IF frequency, achieved by selection of the appropriate combination of VFO and LO frequencies, the signal can be steered through either filter at will, resulting in a receiver with two different receiving bandwidths. One of the filters can be constructed with narrow bandwidth, appropriate for receiving CW (or other narrow modes), whilst the other may be a conventional IF filter for phone modes, as used in the original LBS transceiver.

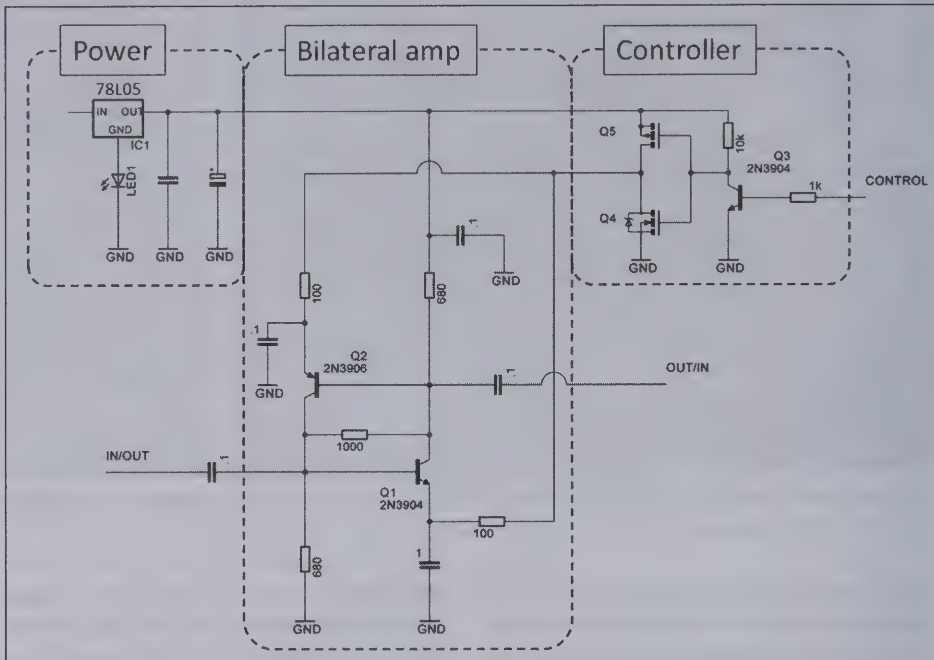


Figure 1—Bilateral amplifier and its Direction Controller.

If a builder does not wish to try the parallel IF method, the second IF filter can be omitted. The circuit described here will then offer a conventional replacement for the LBS module.

Electronic Transmit/Receive Switching

The switching scheme for the bilateral amplifier used in the LBS transceiver [6] connects a single voltage node of the circuit either to ground or to the positive power rail. In the circuits presented so far, this switching is achieved by a simple relay. The new module does away with (some of) the relay sections, achieving the same function from a pair of complementary Field Effect Transistors.

Figure 1 shows one instance of the familiar bilateral amplifier, its power supply and the electronic system used to set the amplifier's operating direction. The amplifier is totally conventional [6, 2]. The power supply introduces a simple dodge to avoid the expense of the 78L06 voltage regulator specified in [2] and replace it with a cheaper and more widely available 78L05 device. The shortfall in voltage is (more than) compensated for by the addition of an LED according to the scheme described (e.g.) in [7].

The "controller" section of Figure 1 accepts a logic control input to specify the operating sense of the amplifier. If the CONTROL input is at 0V, Q3 will be off and its collector will be at the power supply voltage. This will turn on Q4, tying the controller's output to ground. Q5 will be off. Q4 will serve as a low impedance path to ground, just as the relay contact in previous examples of the amplifier, setting the amplifier to "receive" direction (left to right in Fig. 1), in which the 2N3904 is active. Applying a positive control voltage of 3.3V (or more) to the "CONTROL" input will turn on Q3, pulling its collector down close to zero. This will allow Q5 to establish a low impedance path to the positive rail, which will turn on the 2N3906, placing the amplifier in "Transmit" config-

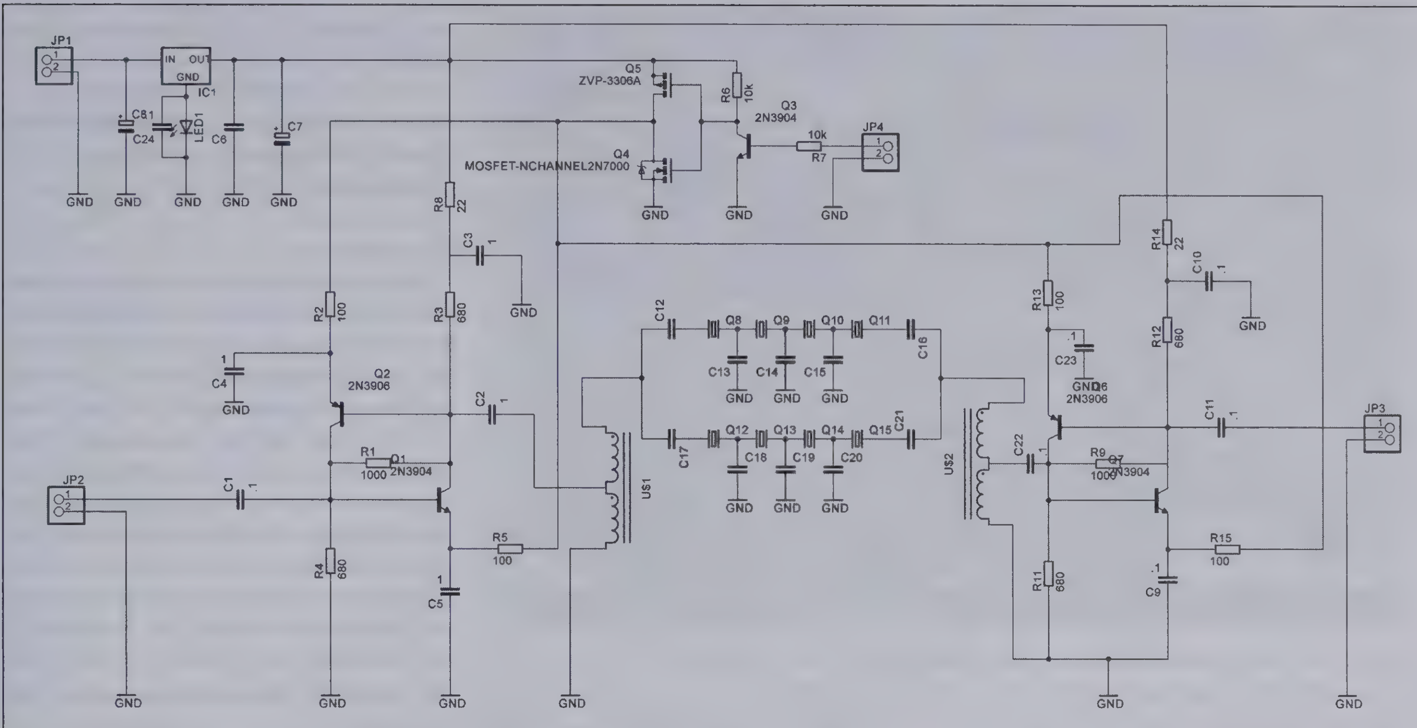


Figure 2—The LBS Parallel IF system.

uration (right to left in Fig. 1). Notice that the 12V Transmit line of the original LBS transceiver could be used as the CONTROL input. The FETs are intended only to switch the DC signal to the amplifier's transistors, as there is a low impedance path from the emitters of both Q1 and Q2 through the 100 nF capacitors. In spite of these capacitors, the non-zero "On impedance" of the FETs is sufficient to allow some very small IF voltage to be measured on the drains of Q4 and Q5. This voltage has not caused any observable disruption of the function of the system.

The n-channel FET, Q4, is an easy find in home-brewer's junk boxes; the ubiquitous 2N7000 will serve very well in this application. The required complementary p-channel device is rather more unusual, especially as a leaded component. Fortunately, N6QW identified the reasonably inexpensive and easily sourced ZVP3306, which works well as Q5.

The Parallel IF Scheme

Implementing the Parallel IF hardware is simple. It amounts to everything suggested in the name—provision of a PAIR of parallel IF filters. These should be of exactly the same configuration as used in the original LBS transceiver, as described in [2].

The filters are designed with different centre frequencies, using crystals of nominal frequency 2 MHz (or more) apart in the two filters. The author has used the combination of 10 and 12 MHz in his receivers - although there is no reason why one of the filters should not be a duplicate of the 4.9152 MHz LBS IF filter originally specified [2]. It is not a good idea to use a filter with centre frequency simply related to the clock crystal in your micro-controller system—so Arduino users should avoid 8 and 16 MHz IFs.

The entire schematic is shown in Figure 2. As in the original module (Figure 7 of [2]), the new circuit has a bilateral amplifier on either side of the IF filter(s). These amplifiers serve the dual purpose of providing gain and impedance matching for the filters. The impedance matching is

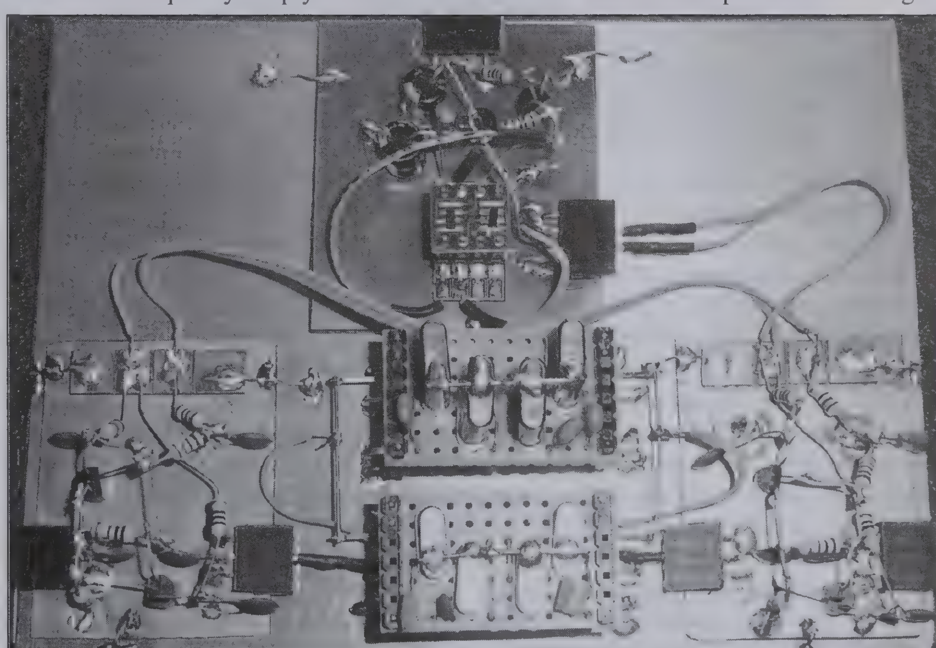


Figure 3—Initial "ugly" development version.

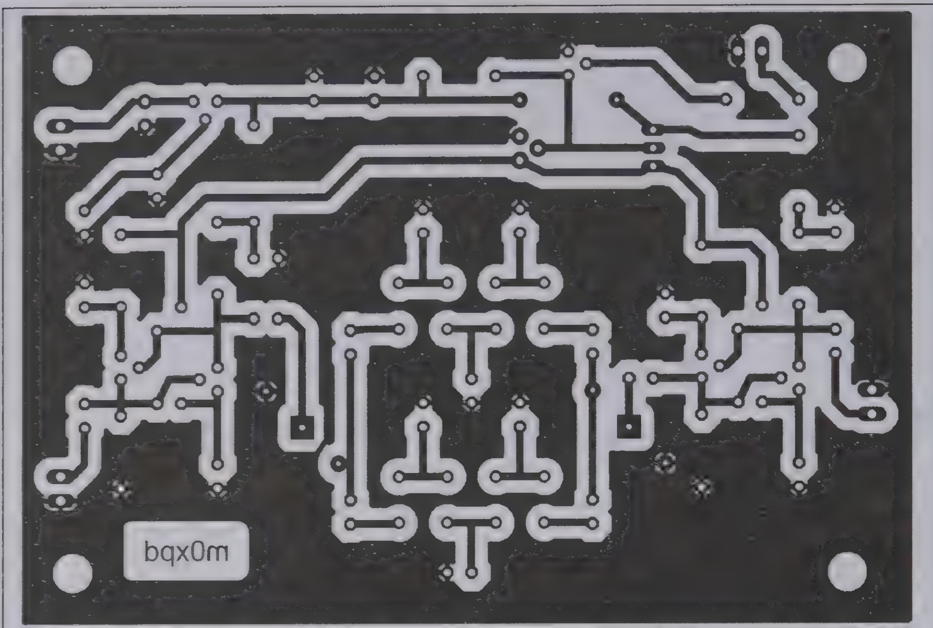


Figure 4—Copper foil pattern, viewed from top side (not full size).

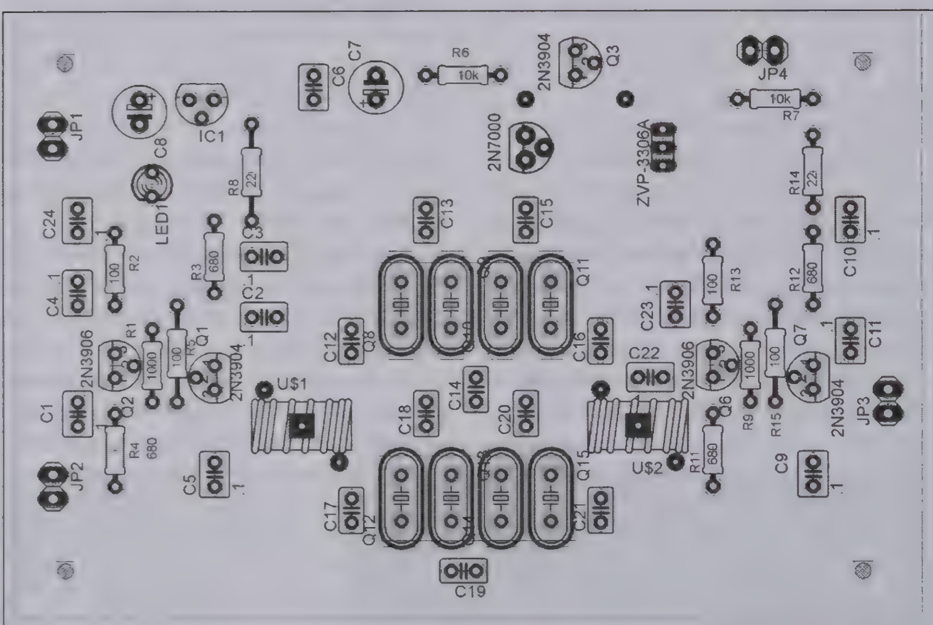


Figure 5—Layout (from top side).

further improved by the 2:1 autotransformers made by the tapped coils U$1 and U$2, which match from the (very) nominal 50 ohms of the amplifier chain to a 200 ohm impedance more suited to the filters themselves. As with the prototype [2], these coils are formed from six bifilar turns wound on an FT37-43 ferrite.

The system was first evaluated in an ugly implementation, which is seen in Figure 3. The ugly version was built to use the plug-in filter modules developed for the author's modular test receiver.

A PCB Design

A design for a printed circuit board to house the system of Figure 2 is shown in Figure 4. The board is 2.5 inches by 3.65 inches when scaled to full size. It is of single-layer construction and can easily be home-brewed using familiar photo- or toner transfer methods. Electronic copies of the foil pattern or the entire design file (in "Eagle" format) are available on request.

The board requires one wire link on the top (component) side. This is easily identified with reference to the component layout shown in Figure 5. The link is placed near Q3.

The link is visible in MØXPD's build of the PCB-based systems, shown in Figure 6. This unit is seen before the filter components were fitted.

Evaluation

Instances of the new module have been evaluated by MØXPD, KK6FUT and N6QW. All were found to operate successfully. As already has been noted, the system may be constructed to host just a single IF filter (as in the original LBS transceiver), in which case little more need be said. During his evaluation, Pete observed that "the board can be simply dropped into the LBS and requires minimal retrofit (this is akin to plug and play)".

If, however, the builder is interested in the Parallel IF method, with its pair of filters, the following additional points may be of interest.

Pete noticed during evaluation of his test system that "On very strong signals you will hear a blow by through the second filter". This prompted some measurement work, reported on MØXPD's blog [8], which demonstrated that both acceptably low levels of this "blow by" (breakthrough the second filter was more than 48 dB down on a test signal passing through the "intended" first filter) and good match between the gains of the two paths (within 2 dB) can be achieved—even with the poverty of MØXPD's filters!

Pete also commented that "The build requires the use of some test gear not found in the average shack—a filter sweeper certainly would be almost mandatory as well as a scope". He went on to observe "Building one homebrew filter is problematic ... building two is an order of magnitude more difficult". It is not within the scope of this article to describe the construction of appropriate filters but, with care, it can be done. The author prefers to develop and test the filters before committing to assembly on PCB, which explains the existence of both the ugly version of the system, Fig. 3, (which uses plug-in filters) and the incompletely populated PCB shown in Fig. 6.

A final point should be emphasised. The Parallel IF method is intended only to be exercised during receive—MØXPD has found no argument to switch between the two IF paths on transmit, using only the

wider (SSB) filter even when transmitting CW or other narrow bandwidth modes.

Closing Remarks

This module has demonstrated a simple elaboration of the LBS bilateral amplifier to substitute the relays with electronic switching. The same approach could be extended to cover all power switching in the transceiver (although electro-mechanical relays still can have a practical use in switching and isolating RF). The module has shown how the sub-assemblies of the LBS transceiver—or any other similar home-brewed project—can be translated onto printed circuit boards. This is especially useful where duplication is anticipated and can also help in miniaturisation, [3], especially if your "ugly" or "Manhattan" projects are as ugly and space-inefficient as MØXPD's! Finally, the module facilitates experimentation with the Parallel IF method. An Arduino sketch to control an Si5351 to operate a Parallel IF system, such as that presented here, can be obtained from the author [9].

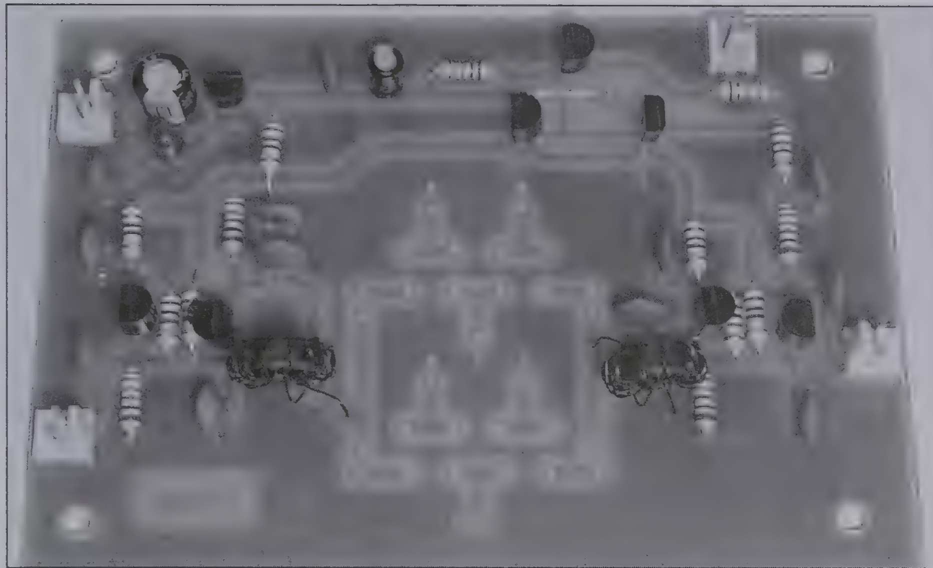


Figure 6—MØXPD's build of the new module (without filters fitted).

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Solder-lug Substitutes for "Spade Bolts"

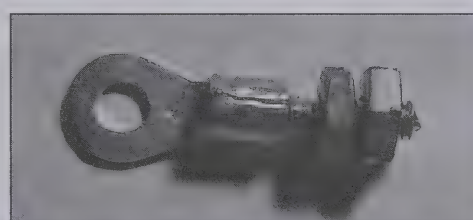
Brad Thompson—AA1IP *brad.thompson@valley.net*

The spade bolt ranks as one of the more useful components in any collection of electronics hardware. In vacuum-tube days, some IF transformers featured two spade bolts for attaching a transformer's shield can to a chassis. Nowadays, you can use spade bolts to attach a printed-circuit board or subassembly to a chassis.

Unfortunately, with prices hovering around $1.00 each, searching distributors' web sites for spade bolts can induce "sticker shock"! Here's one approach that uses components you may already have on hand to produce an inexpensive substitute. While odds are good that someone has previously described this method, it's worth repeating in case the original concept is lost in pre-internet history.

Start with a 6-32 by 3/4 inch brass flathead or roundhead screw and two hex nuts. Threading the two hex nuts onto the 6-32 screw. Position the nuts next to the screw's head. Using pliers, flatten some rosin-core solder into a ribbon and insert it into the lug's crimp sleeve.

Thread or force the screw's threaded end partway into the crimp sleeve. The solder will serve as a shim and help hold the



screw in place. Use a high-wattage soldering iron or gun to heat the crimp sleeve's exterior until the solder melts. Add a little extra solder to the crimp sleeve's interior. When cool, use heavy-duty sidecutters or a Dremel™ tool and abrasive-cutoff disk to cut off the screw head.

Hold the lug's flat surface with pliers. Use a hex-nut driver or wrench to unscrew the bottom-most hex nut to remove any burrs left on the thread when cutting off the screw head.

As you would attach a spade bolt, use a #10 screw or pop rivet to secure the lug to an IF can or printed-circuit board. Attach the threaded portion to the chassis by placing the upper hex nut against the chassis top and tightening the bottom hex nut against the chassis' underside. For best results, place lock washers between the top and bottom nuts and the chassis.

Note: I used an uninsulated lug punched for a #10 stud and specified for crimping onto AWG #10-AWG #12 wire.

Review: LD-5 HF QRP Transceiver

James Hannibal—KH2SR

kh2sr@arrl.net

The LD-5, made in USA by LNR Precision Inc., is an amazing little QRP 5 band SSB/CW Amateur Radio Transceiver that's small and light enough to fit in just about any backpack, thus making this one of the most portable SSB multi-band HF rigs currently on the market. Not only is the LD-5 small in size at 4.724" L x 3.937" W x 1.957" H, it is also very lightweight, weighing in at only 1.19 pounds (without microphone, antenna, or battery).

The LD-5 covers the 40m, 30m, 20m, 17m, and 15m HF ham radio bands. One of the features of the LD-5 I have really enjoyed is how each of the 5 bands has its own independent dual VFO. This really comes in handy when switching back and forth between bands/frequencies and really sped up operations for me compared to other QRP rigs I have used. I found the receiver to be exceptionally sensitive and able to pick up the weakest of signals.

There are a few features that you typically wouldn't find on most QRP HF rigs that the LD-5 has, such as CW/SSB VOX, noise blanker, notch filter, noise reduction, PRF/ATT (Pre Amp/Attenuator) and even speech compression. Based on my testing, I found all of these features extremely effective at improving my ability to hear and be heard by other hams. I am convinced that several of of the contacts I made would have been impossible if I didn't utilize the various filtering, noise reduction, and speech compression capabilities that are built into this amazing little radio. As far as I know, the LD-5 is the only 5 band QRP SSB HF ham radio with all these features that is sold new for less than $600.

The LD-5 is capable of much more than just SSB and CW. It is also capable of various digital modes such as PSK, RTTY, SSTV, and even HF APRS when used with the proper TNC/modem and computer with sound card. The menu system contains nearly two dozen settings that allow you to custom tailor the LD-5 to suite your specific needs and preferences. Luckily, there are also 13 buttons and 2 knobs on the LD-5 that allow you to manipulate many features without diving into the menu system. The tuning knob also has a really good sturdy feel and smooth movement while tuning. I especially enjoyed the bright and high contrast display with its power saving auto off feature for the backlight.

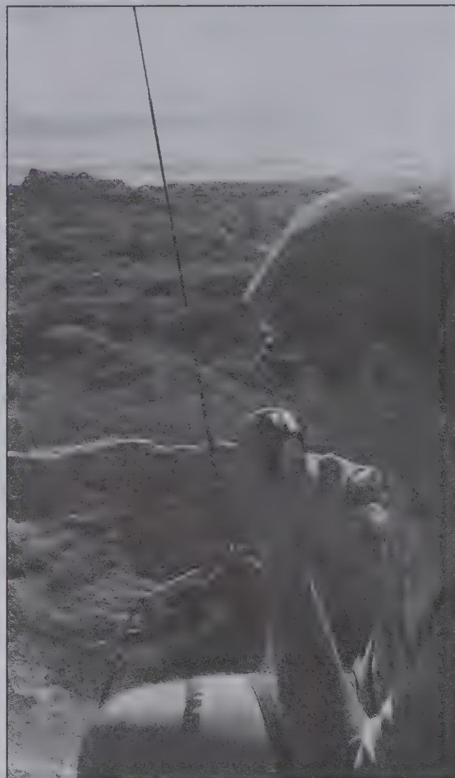


Photo 1—The author, James, KH2SR, enjoys a bit of beachfront operating with the LD-5 and a simple portable antenna. (All photos are by the author)

You might not realize it when looking at it but the LD-5 is actually an SDR (Software Defined Radio) with a software platform that was created exclusively for the LD-5. It uses only one Kenwood driver for CAT system fast connectivity. When I asked LNR for more details on this being an SDR, they quickly gave me the following very detailed response:

"It combines a powerful low internal noise schematic of a DSP and a special differential algorithm is applied for IQ processing of the channels with phase suppression of the unwanted side-band channel. Balancing ADC and DAC gives additional noise floor reduction and the receiver can handle interfering signals that are 100 dB stronger than the desired signal at a frequency separation of 10 kHz, and is about 130 dB stronger at 50 kHz separation. As the receiver and transmitter are using the same DSP channel, there is no gap between the receiver performance and the transmitter performance. So, there is a clean neighborhood on the bands. At the development stage, our intentions were motivated by the TX sideband noise of existing SDR manufacturers, so our aim was, to fully equalize our transmitter to have noise performance that is compatible with the best modern receivers, or even better. After a arduous year of development, we think we achieved it."

A nice assortment of input and output ports allow you to widely customize the way you use the LD-5. These include jacks for: line in/out, phone out (headphones/speaker), mic in, key (CW straight key or iambic paddles), PTT out, BNC antenna connector, 12 volt DC power input, and even a USB/CAT port. The built-in USB port is another stand out feature on the LD-5. Not only will the USB port allow you to update the radios firmware, it will also allow you to interface the LD-5 radio with your computer, which allows you to use Mac/PC ham radio software programs such as N1MM, MiXW, Fldigi, and more.

During my field testing of the LD-5, I brought it along on a road trip up and down the California, Oregon and Washington coastline. When stopped long enough, I would set up the EFT-MTR 40m/30m/20m 65' QRP End Fed antenna (also made by LNR). On one occasion, I was fortunate enough to stay on the second floor of a bed and breakfast situated on a hill. This allowed me to drape the 65' EFT-MTR End Fed antenna out the window and down the roofline in somewhat of a sloper configuration, which worked quite well with the LD-5.

During shorter stops at various beaches and state parks along the coast, I set up the LD-5 with my "Wonder Wand" and "Miracle Whip" antennas, which set up in seconds, packs up small enough for most backpacks, and don't require a mast, ropes, tripods, clamps or long wire. Both are all band 52" vertical telescopic whip antennas with a built-in dial for tuning to each band. These antennas work fairly good with the LD-5 and I have been able to make contact

with hams that were within a couple hundred miles away while using them.

During another trip, I used the same 65' End Fed EFT-MTR from LNR in a sloper configuration with a 22' collapsible fiberglass mast while camping on a beach near Santa Cruz, CA. With that particular setup, I made SSB contacts on 20m and 40m at 573 miles into Oregon, 676 miles into Washington State, 202 miles into Nevada, 657 miles into Idaho, and 860 miles into Montana. With each of these contacts, I was only using 4 watts of RF power output.

A couple of my longer distance SSB contacts using the LD-5 included several different contacts that were 1,352 miles away in Kansas on 20 meters while using only 5 watts. My longest distance contact with the LD-5 so far was a 2,349 mile contact on the 15 meter band made to New York, again with only 5 watts of output power. The antenna I utilized to make these contacts is my Carolina Windom 40 off center fed dipole, which is up around 30 something feet off the ground in an inverted-V configuration.

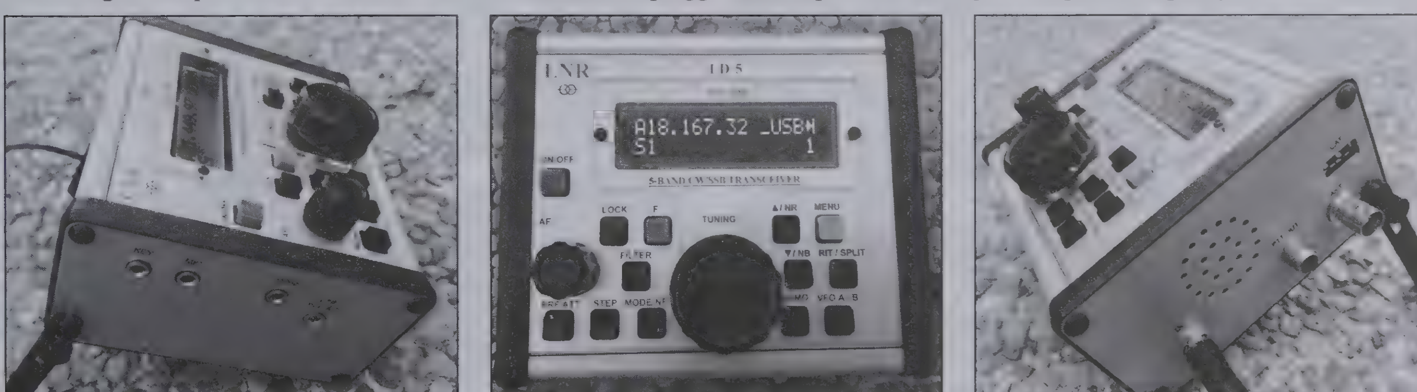
The LD-5 is known for being able to make much long range contacts than I have made with it so far. For example, my contact at LNR Precision Inc. informed me that while conducting a demo of the LD-5 at the Huntsville, AL Hamfest this year, a customer made contact with a fellow ham operator located on Rodrigues Island in the Indian Ocean while using a simple 20 meter end fed antenna oriented vertically which is made by LNR. Thats an impressive 10,330 miles! Not too shabby for a 5 watt radio that can fit inside a kid's lunch box.

As far as the performance of the included microphone is concerned, I think it works great. It produces clean and clear audio without any noticeable over modulation, even when talking quite loud into it. A small speaker is built into the right side panel of the radio. The speaker produces decently clean audio but is a little on the weak side when it comes to audio volume output, especially when there are background noises such as road noise, wind, or waves breaking on a nearby beach. If you are in a nice quiet spot, the speaker works great, but if there is any background noise, I recommend using headphones or an external amplified speaker.

Photo 2—A package like this contains a complete portable QRP station, including battery, antenna and accessories.

Even though the included mic works great, in my opinion, it's not the best fit for this radio. Considering this radio is designed to be compact for portable use such as backpacking, I find it odd to include a microphone that takes up nearly the same amount of space as the radio itself when packed. Luckily, the included mic can be unplugged and replaced with whatever kind of mic you prefer to use. I plan on modifying a MFJ-285 mini HT speaker microphone to work with the LD-5. These little inexpensive HT mic's are roughly 1/4 the size of the included mic and might be better suited for QRP backpackers with limited room in their packs.

A power plug and cable with bare ends is also included for you to connect to the battery or power supply of your choice. The LD-5 is designed to be powered from 10.5 volts to 15 volts DC. I happened to have 2 fairly compact 12 volt batteries on hand. One is a SLA (Sealed Lead Acid), the other is a LiPo (Lithium Polymer). The LD-5 worked flawlessly with both types of batteries. If you plan on carrying this radio around in a backpack, I highly recommend going with a small 12v lithium battery since they weigh around 1/3 the weight when compared to an SLA battery of comparable power capacity. You might also



Photos 3, 4, 5—Left side, front panel and right side views of the LD-5.

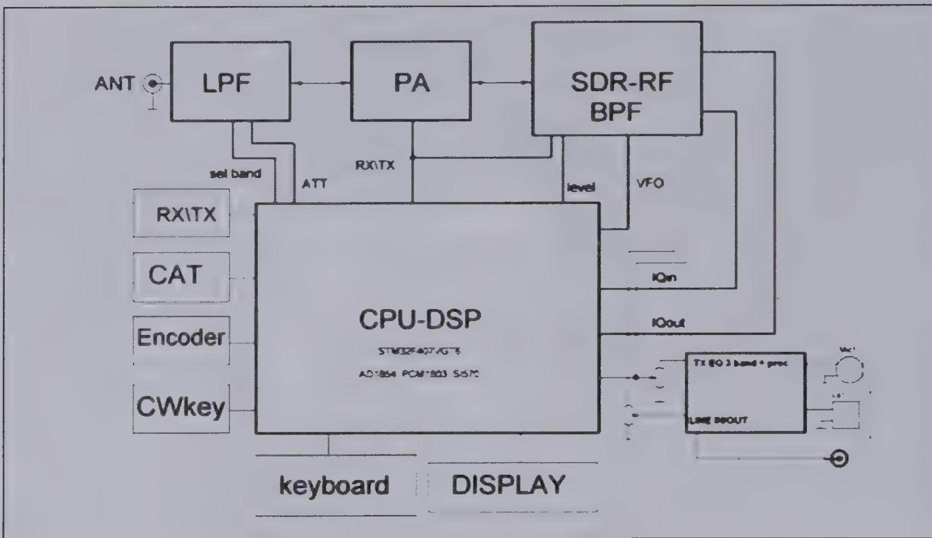


Figure 1—Block diagram of the LD-5, showing the configuration of its, RF, SDR and control functions.

Transmitter Output Power: 3.5 - 8 W
Two Modes CW: Select Straight Key or Paddle
Receive sensitivity: 0.2 uV Preamp
Ant Preamp: +12 dB
Spurious Response Rejection: IMD3 –48 dB / 5W IMD5 –43 dB
Attenuator: –6 dB
Frequency Range: 7 - 22 MHz — 40, 30, 20, 17 and 15 meter operation
Modes: USB, LSB, CW, CW-R, DIGITAL DATA: CAT-USB jack — CW, PSK, RTTY, SSTV: 3.5 mm input/output audio jacks
Frequency Stability: +/– 3 ppm (Si570 defined) typical over 0-50 deg C
Supply Voltage: 10.5 to 15 V. max 350 mA receive and 1.5 to 2A typical in transmit
LO temp. Stability: +/– 2.5
Antenna: 50 ohms BNC
Dual VFO
Memory: 100 memory storage per band, Memorize frequency, mode, VFOs
Built-in speaker: 0.2 watts
Dimensions: 4.724"L x 3.937"W x 1.957"H
Weight: 19 oz/0.54 kg (excluding mic.)
Iambic key: Mode A and Mode B
Pitch CW: Controls CW offset. Sidetone pitch automatically set to equal the offset
Notch Filter: Automatic Heterodyne filter for SSB from –6 to –40 dB
Noise reduction: Attenuation of the noise from 1 to 50 — use minimum necessary
Noise Blanker: Adjustable range from value 4 to 12, depending on interference
CW VOX: Break in delay in CW - adjustable from 0.1 seconds to 5 seconds
CW memory keyer
Voice VOX: Delay adjustable from 0.1 to 5 seconds
SSB VOX Level: VOX Ggain 10-100 10 is most sensitive
8 different filters (incl): 4 of 4 for CW/ SSB — 1-3 factory presets — No. 4 adjustable for CW: 50-1000 Hz; and SSB: .250-3.6 kHz
Compressor: SSB: 0-20 dB

Table 1—LF-5 specifications.

want to consider a small lightweight folding solar panel so you can keep your battery topped off when operating from the great outdoors.

I was fortunate enough to have a spare small waterproof foam padded hard case that is not much bigger then the LD-5. There was just enough room in the case to also cram in a lithium battery, power cable, mini straight key, headphones, counterpoise, small logbook, mini pencil, and a printout of the ARRL band plan for good measure. This allowed me to pack the LD-5 into a backpack and hit the trail without worrying about it getting banged up against my other gear. Protective cases such as this are in my opinion a necessity and can be easily found in a wide variety of local and online stores.

One of the really nice finishing touches on the LD-5 isn't high tech at all. It's the little fold out legs that allow you to conveniently prop up the radio at a much more comfortable viewing angle. So many QRP radios and kits out there just don't come with a stand/foot and it can really impede your ability to use the radio. To me, this simple feature is the icing on the cake for this radio, making it a real pleasure to use.

I have used several different portable HF QRP rigs now and even built a few myself. Out of all of them, the LD-5 from LNR is by far my favorite. I found its ability to filter noise and pick out those weak signals very impressive. It has tons of great features, quick to setup, easy to operate, reliable, and just plain fun. Its compact size and lightweight construction make it an ideal radio for portable operations such as camping or backpacking. I can tell that LNR takes great pride in their work based on the build quality of their products as well as their staffs willingness to happily help you out with any questions or problems you might possibly encounter. I highly recommend this radio for anyone who is interested in operating portable QRP in the great outdoors without breaking the bank.

For more info:

LD-5 QRP HF Ham Radio Transceiver: http://www.lnrprecision.com/store/#!/LD-5/p/39885476/category=10468544

EFT-MTR 40m/30m/20m End Fed Antenna: http://www.lnrprecision.com/store/#!/EFT-MTR/p/52039905/category=10468543 ●●

QRP Clubhouse

Timothy Stabler—WB9NLZ editor@qrparci.org

Sorry for including so little club information, but not much has come in to report on. C'mon clubs, send me your latest news ... or should I retire?

East Central Indiana QRP Group

In October, the group held its semiannual meeting at the Maring Hunt Library in Muncie, Indiana. The first part of the meeting was a talk by Richard Meiss (Figure 1), WB9LPU on keys and bugs. Not only does Richard make and sell them, but also has an excellent collection from many different sources. He went through the types of electrical connections each has. If you want to see a variety of keys that he makes (Figure 2), go to his website, wb9lpu.com. He did tell us of the time he went to Dayton to get a Bengai key (Figure 3). When he stepped to the booth, Bengali came to see him and to tell Richard he wanted one of Richard's keys. After talking, they exchanged keys and are both happy now. After a coffee break, we got into the second session of the meeting where everybody present has an opportunity to speak of a project they are (or were) working on. Donnie, WA9TGT, spoke of a key he had gotten and totally refinished. I brought everyone up to date on Ozarkcon, 2015. There were some other things brought up but I managed to not have anything to write on, so I have to remain sketchy here. Donnie has sent out he meeting dates for 2016 which are Saturday, April 9th and Saturday, October 8th. I am sure everybody will be happy to see anyone that comes. Remember, the meeting starts at 12 noon and you have to be ready to go in as the library is closed on Saturdays. In the Spring, the meeting will be for only two hours so no one gets charged for the extra hour that we have been using.

HQRP MosQRPitos

Just before I wrote this, I got an email from Mark, K5MGJ about a group build. The group (Figure 4) got together on December, 12th for a group build of the 4SQRP's tuner (Figure 5). They .liked the group build as everyone could not only share tools and jigs but also could check each others work. They were hosted by Ron, AG5RS in his workshop/barn in Brookshire, TX. To them it seemed like a QRP quilting bee. They did have the barn door open, so when a cold front passed through, soldering irons cooled. Mark did check his and found it working fine.

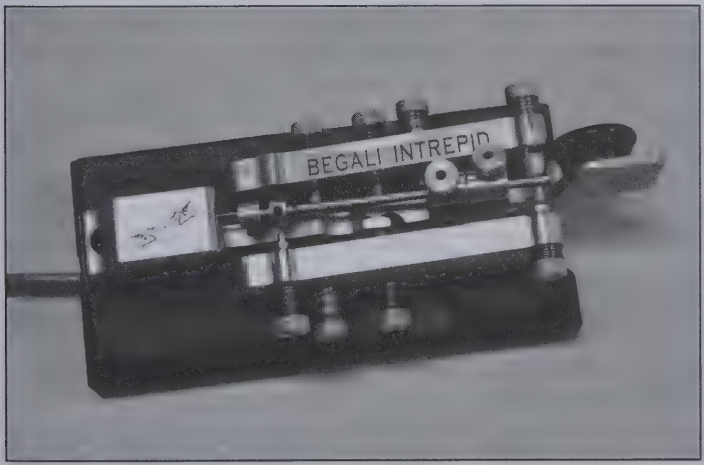
Any other group builds in the future?

—72, Tim, WB9NLZ

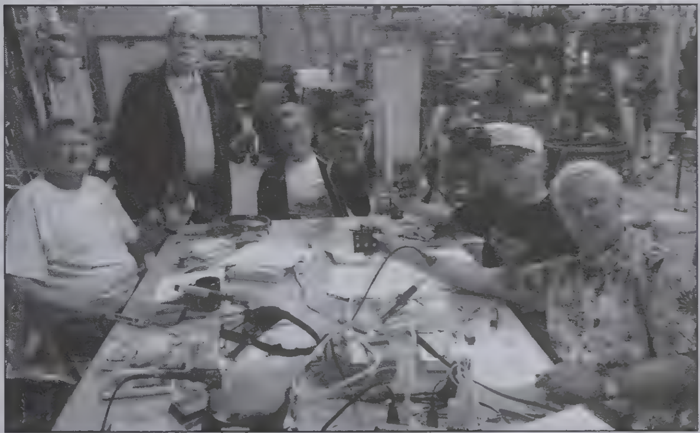
Tim is the Editor of QRP Quarterly *and writes this column. Send news about your QRP/homebrew club to Tim at: editor@qrparci.org*

Richard Meiss, WB9LPU, gives a talk on keys.

A series of keys that Richard has made.



The key Richard received from Begali.



The MosQRPitos builders (left to right): Tony, N5RPQ; Ed, N5EM; Andy, W5ACM; Charlie, K5ENG; Mark, K5MGJ.

Second Harmonic Suppression

Ward Harriman—AE6TY ward@ussu.us

Being a Good Neighbor on Field Day and Expeditions

The author wrote the article below concerning a particular issue of harmonic suppression. However, in addition the article shows a general method for modeling an antenna and feed line system, the effects of feed line length, and the effects of impedance matching. Most of the results were generated using SimSmith, a program devised by the author of this paper. —Editor

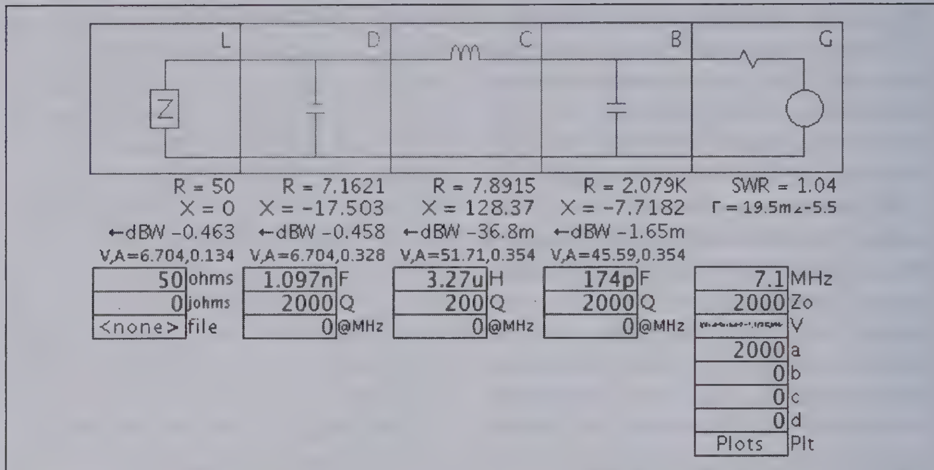


Figure 1—Circuit model for a Pi network driving a 50 ohm resistive load on the left and a tube amplifier final on the right.

Operating in close proximity to other stations requires extra care in controlling spurious emissions. Of particular concern should be the design of the feed line. oor feed line choices can render a transmitter output filter ineffective. Good feed line choices and adding filters made of coax can make a difference of over 70 dB.

Most of the time we hams are trying to figure out how to maximize output power. In that quest, we often forget that we need to MINIMIZE power output in the harmonics. Indeed, the FCC tells us that below 30 MHz, we need to keep our harmonic power 40 dB down from the intended signal.

Generally, we rely on our low pass output filters to make sure we satisfy this requirement but there are times when the 'stock' filter may prove inadequate. In this article, I'll describe a situation where our output filters don't always work, how we might insure they do, and what we might want to do to further suppress the spurious emissions. Consider this,

Suppressing harmonics is an act of filtering. As with all filters, you must engineer both the input and the output impedances of the filter; to ignore either end sets you up for failure.

In this article I will be using a tool called SimSmith, version 11.5. This tool is tailored to working with Smith, SWR, and Power charts. As with most Smith chart tools and for historic reasons, SimSmith starts with the antenna on the left and the transmitter on the right. This is backwards compared to most electronic drawings. Be forewarned.

Note: what follows discusses a typical tube amplifier. Solid-state amplifiers have different voltage and impedance transformation requirements but the issues discussed are the same regardless.

Tube amplifiers generally have an output filter called a Pi or Pi-L network. This output network has two functions. First, tube amplifiers are generally designed to work at high voltages and to drive high impedances. Thus, the output network must transform the high impedance of the tube output stage down to our feed line impedance that is usually 50 ohms. Second, the Pi network must provide some low pass filtering because power amplifiers are often rife with harmonics.

Figure 1 shows five circuit elements. On the left is the 50 ohm load representing the antenna. Then there is a 1.097 nF capacitor labeled D, a 3.27 uH inductor labeled C, a second capacitor of 174 pF, and a block called G. The G block represents the tube output stage.

As discussed above, the first job of the Pi network is to convert the high impedance needed for the tube output stage to the low impedance of our antenna. Looking at the above circuit, immediately below each circuit element is a line of the form "R = " and below that a line of the form "X = ". The R represents the resistance looking toward the antenna (leftward) and the X is the reactance. As can be seen, the 'L' circuit element has a resistance of 50 ohms and a reactance of 0. Underneath the B element we see a resistance of 2.079 kohms and a reactance of –7.7 ohms.

There are other lines under the circuit elements. For example, below the B element there is a line of the form "<–dBW –1.65m". This tells us that the generator is delivering –0.00165 dBWatts into the B element… that's very close to exactly 1 watt. Indeed, the G circuit element is configured to deliver 1 watt into a load of 2000 ohms. Notice that the Pi network has some loss; in this case about 0.46 dB.

The circuit in Figure 1 was 'tuned up' to run at 7.1 MHz. What happens when we change the frequency? SimSmith can show us the power delivered to the load as a function of frequency.

Figure 2 shows power delivered to the load as a function of frequency. As can be seen, the power delivered to the 50 ohm load peaks at the design frequency of 7.1 MHz. As the frequency increases, the output power falls. At the second harmonic, the power output is down 40.5 dB; pretty much exactly what we want. Unfortunately, the story is far from over. (Note, the reduction is not due entirely to the Pi network. This model of the tube final has harmonics that fall off at 6 dB per octave. Thus, the Pi network really only provides 34 dB of suppression.)

So far, a 50-ohm resistor represents the antenna and it is expected that a real antenna will act differently. SimSmith allows us

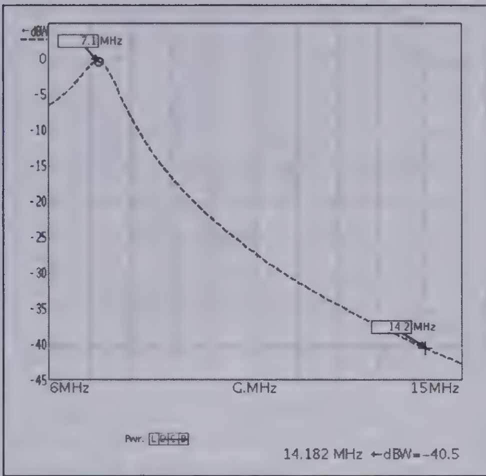


Figure 2—Power delivered to a load of 50 ohms as a function of frequency.

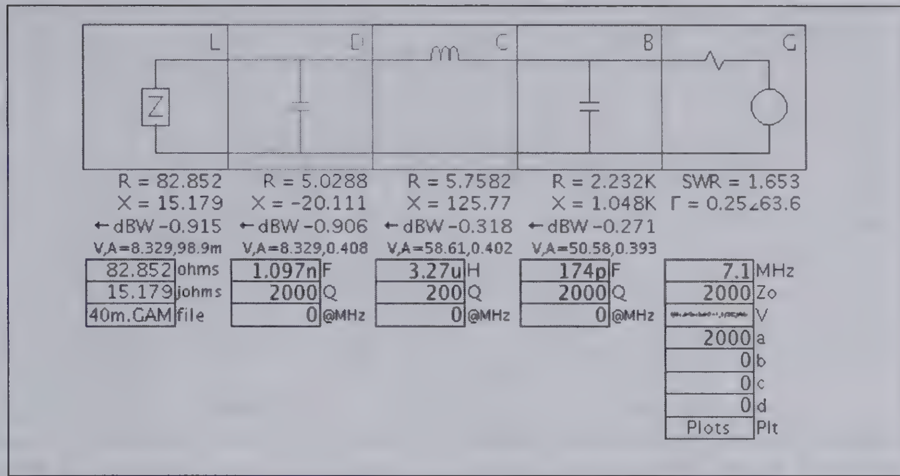


Figure 3—Basic Pi circuit with a frequency dependent model for the load provided by EZNEC.

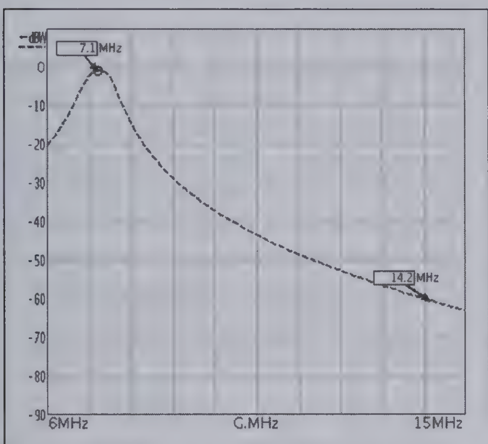


Figure 4—Power delivered to a dipole antenna as modeled by EZNEC.

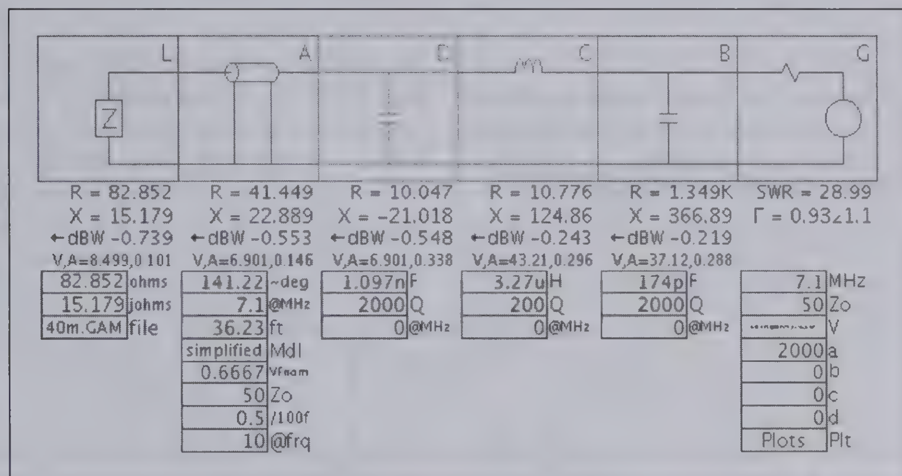


Figure 5—The circuit augmented with a feed line.

to replace the simple 50-ohm resistor with an actual antenna model or actual antenna measurements. In Figure 3, the load is described using an antenna-modeling program called EZNEC. (Other antenna modeling programs can be used: MMANA, 4NEC2, cocoaNEC, NEC4, etc.)

Notice that the L circuit element uses a parameter named 'file' that has been set to '40m.GAM'. The '40m.GAM' file was generated by EZNEC. In this case, it is a simple dipole resonant at 7.1 MHz (or so). Figure 4 shows how the power delivered to the antenna is affected by the frequency dependent model from EZNEC.

Notice that the power delivered at the second harmonic is now down almost 60 dB. Lots of room! Unfortunately, the job is not complete as there is no feed line (yet). As might be expected, we can add a feed line to the circuit as shown in Figure 5.

(There is a potential for confusion when talking about transmission line length because there are two ways to measure their length: 'physical length' and 'electrical length'. The ratio of 'electrical' to 'physical' is called the *velocity factor*. SimSmith always reports 'physical' length and velocity factor. SimSmith never reports electrical length.)

The feed line in Figure 5 is about 36 feet long, perhaps a bit short but chosen to demonstrate a point. Figure 6 shows what happens when this feed line is used.

As Figure 6 shows, second harmonic is now down only about 32 dB; we are violating the FCC rules on spurious emissions and, perhaps more importantly, disrupting our neighbor's use of 20 meters. By the way, using a low loss feed line only makes this worse.

Figure 6 shows the power delivered to the antenna as a function of frequency. A different view is to examine power as a function of feed line length. Figure 7 shows the power delivered to the load at 14.2 MHz as the feed line length is varied.

Notice that there is a 26 dB difference between the 'best' feed line length at about

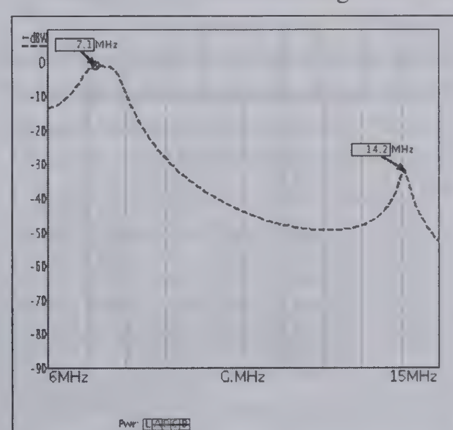


Figure 6—Power delivered to the antenna at the second harmonic with a poorly chosen feed line length.

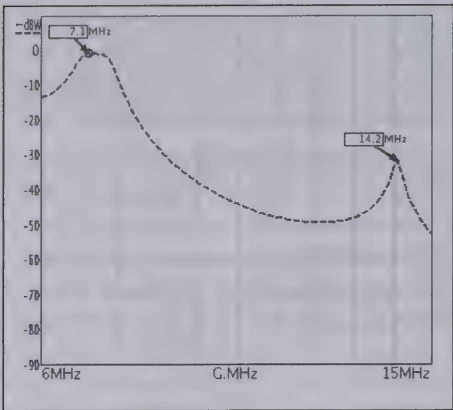


Figure 7—Second harmonic power delivered to the antenna for various feed line lengths. Note that the ‘worst’ length is around 36 feet and the ‘best’ is about 48 feet.

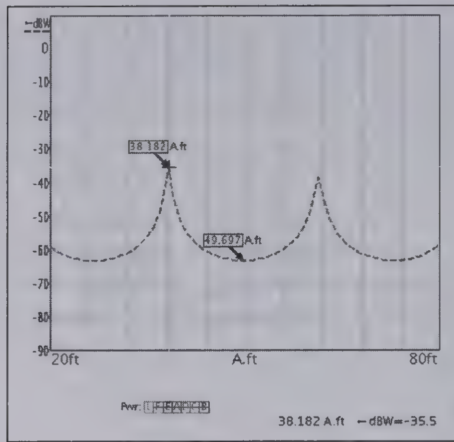


Figure 9—Power delivered at the second harmonic after the antenna is matched.

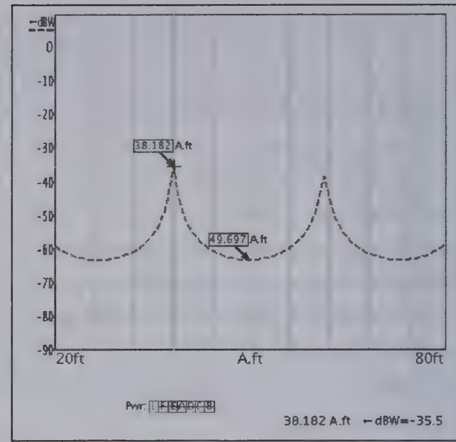


Figure 11—Suppression of the second harmonic using a Pi-L network.

48 feet and the ‘worst’ length of about 36 feet; a gentle reminder that we hams need to engineer our feed lines.

To that end, the aggressive designer may well take exception to the fact that at 7.1 MHz the antenna was not properly matched. Might that make a difference? In the following example, the antenna is tuned at the feed point using a 12th wavelength technique. This matching technique works very well with simple dipoles.

One twelfth wavelength matching requires two short pieces of coax, one at the desired impedance (50 ohms) and one at the load impedance (roughly 80 ohms). For these purposes, a piece of 75 ohm coax will be substituted. Figure 8 shows the new system with the 12th wavelength matching circuit. The two pieces of coax labeled F and E implement the match. Notice that the R and X values under the ‘E’ circuit element show a resistance of 50.008 ohms and a reactance of 0.01

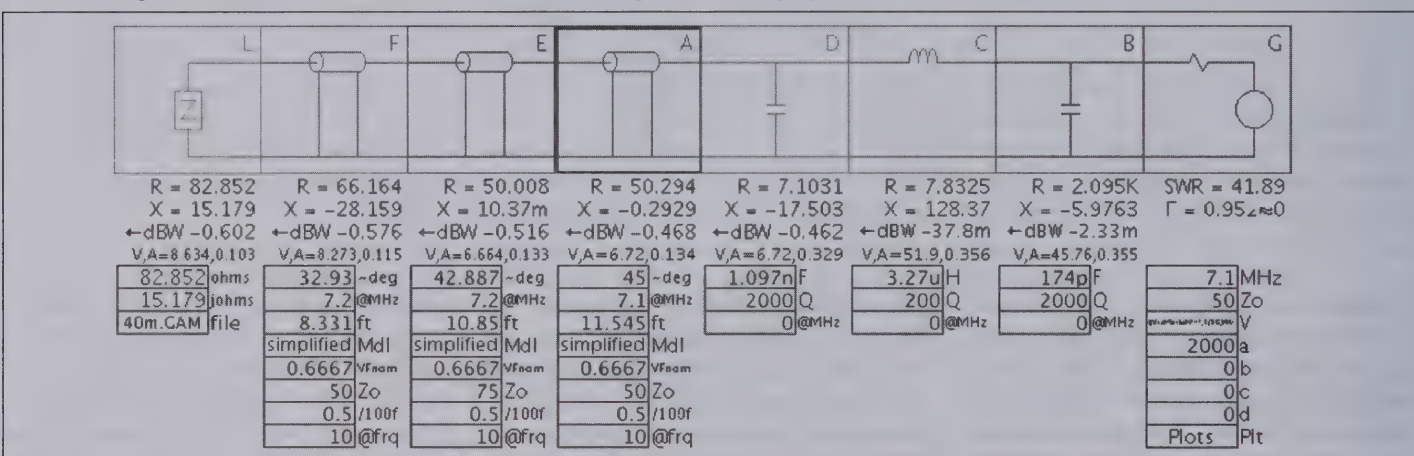


Figure 8—The antenna is matched using a 1/12th wave length matching technique.

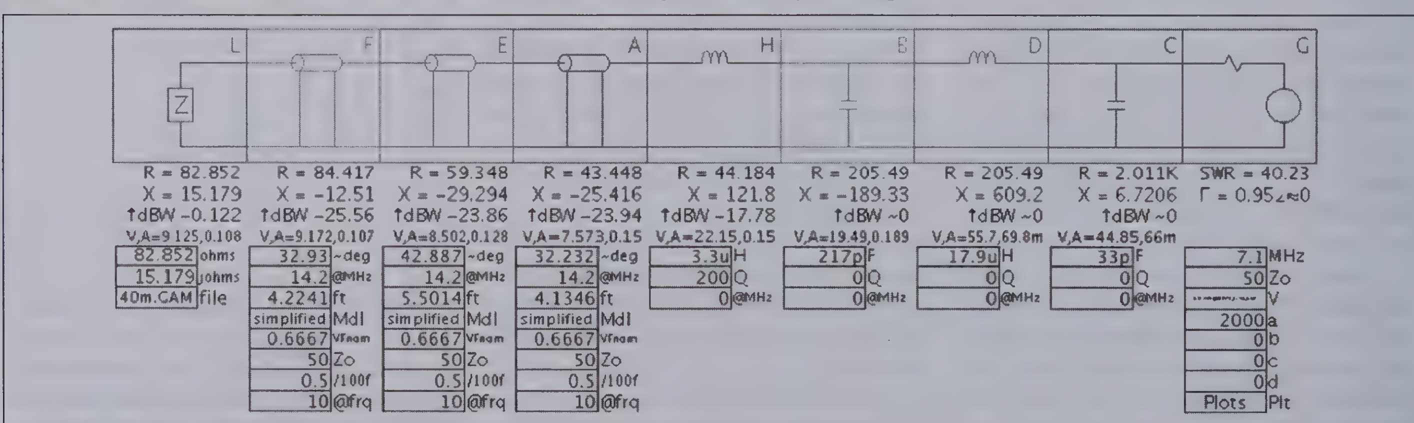


Figure 10—Addition of a second inductor to create a Pi-L network.

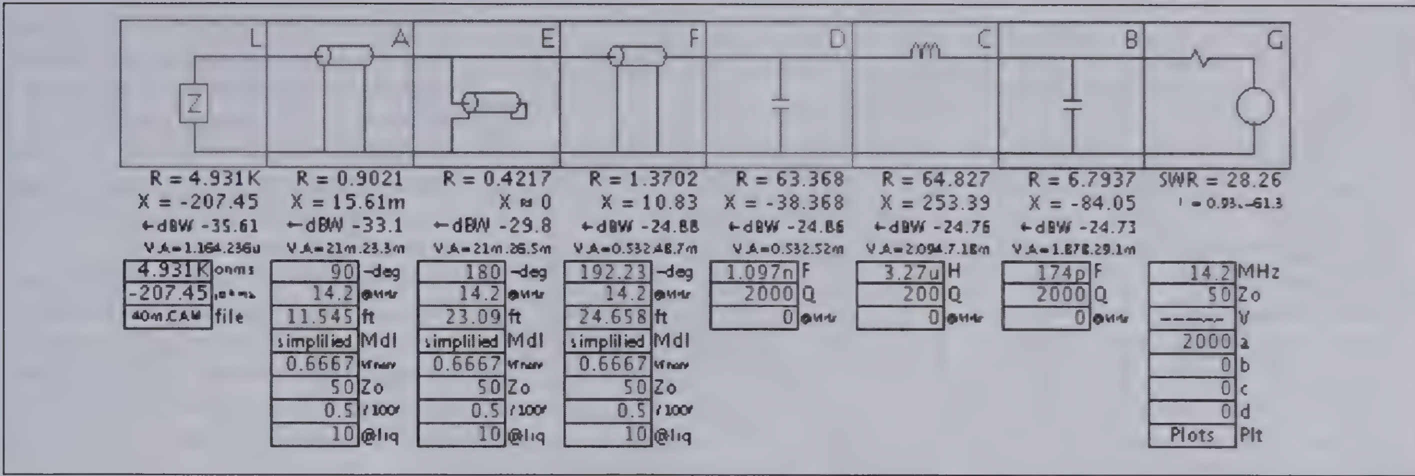


Figure 12—Circuit after adding a stub element.

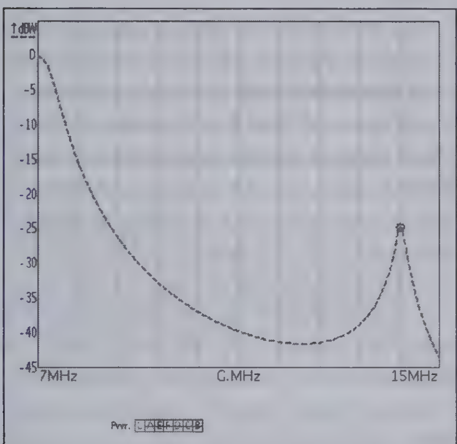


Figure 13—Results of bad feed line length choices.

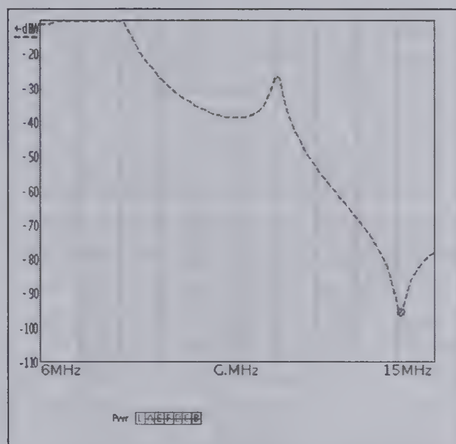


Figure 14—Best choices for lengths of A and F result in a 96 dB reduction in second harmonics.

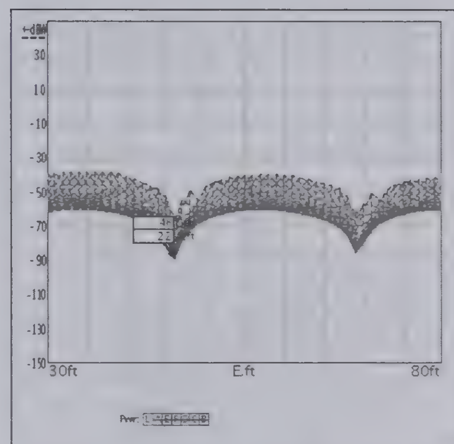


Figure 15—A multivariable sweep can be used to choose lengths for F and A feed line

ohms; a very solid match.

Returning to the second harmonic, how much power is now delivered to the antenna? The power delivered as a function of feed line length is shown in Figure 9.

While there may be some difference, that difference is quite small. A variation of nearly 30 dB is still evident, the length of the feed may be even more critical now than before the antenna was properly matched.

A common alternative to matching the antenna at the feed point might be to match the antenna at the transmitter. While the Pi network can be used to do this, a second L network is more common. (In reality, the L network is implemented by simply adding an inductor to the output.) Figure 10 shows the addition of the inductor and Figure 11 shows the resulting suppression; a dramatic improvement.

So, for casual operation, a Pi-L network with an antenna tuner will probably meet the spurious emissions requirements below 30 MHz regardless of feed line length.

However: There are times when one might want to suppress the second harmonic even more. Good examples are Field Day and DXpeditions, i.e. any time multiple stations are in close proximity and working harmonically related bands. For these situations, how might we improve on the above level of suppression?

A common technique used to reduce second order harmonics is to put a 'stub' on the feed line. The stub length is chosen so that at the operating frequency the stub presents a high impedance and at the 2nd harmonic it represents a low impedance. In effect, the idea is to 'short out' the feed line for the second harmonic. The simplified circuit is shown in Figure 12.

Coax segments A, E, and F model the feed line and the stub. Note that at the second harmonic the resistance at element E is very low (0.4217 ohms!); the feed line is effectively shorted out! How well does this work? Well, it has already been shown that the length of the feed line can have a significant impact. Now there are TWO pieces of feed line to explore, the length of A and the length of F.

Figure 12 shows one choice of lengths for A and F and Figure 13 shows the resulting harmonic suppression. Observe that the stub has had essentially NO EFFECT. This is because the feed line lengths have been purposefully chosen to show the worst case.

However, the 'best' choices for lengths of A and F are substantially different as is shown in Figure 14. Suppression is down nearly 96 dB. The lesson: putting a 'shorting stub' on the feed line can result in NO-EFFECT or it could improve things by 60 dB! Small wonder some folks report the shorting stub has no effect and others report spectacular results.

Now that the critical nature of feed line

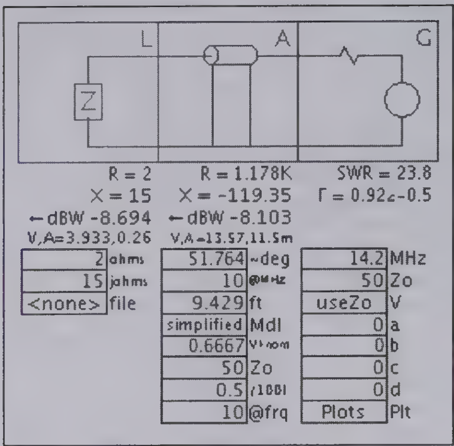


Figure 16—Adjusting the length of the feed line.

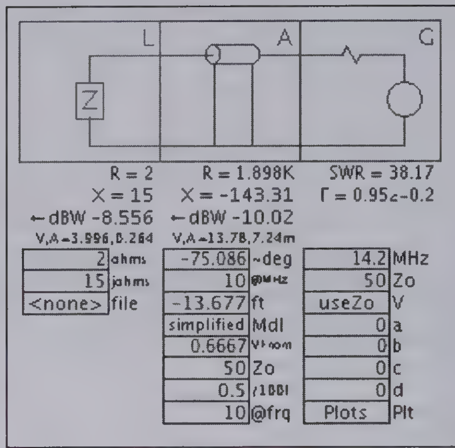


Figure 17—Shortening the feed line as an alternative to adding feed line.

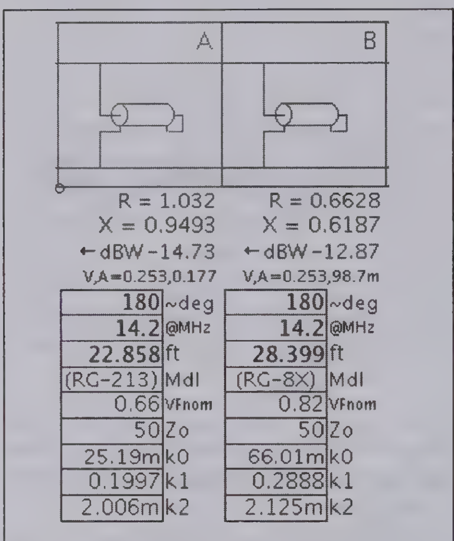


Figure 18—SimSmith calculations for stub length for two commonly used coax transmission lines.

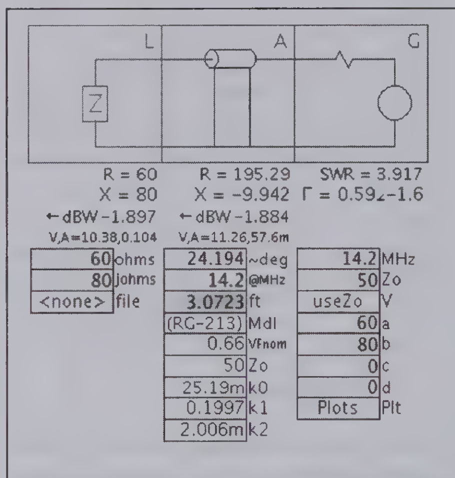


Figure 19—A circuit with the transmitter impedance entered and the feed line length adjusted for maximum impedance.

length is understood, how can the system designer choose the appropriate feed line lengths? There are two ways this can be done: either in the field with your trusty impedance meter or in simulation which, of course, needs to be verified in the field. The advantage of simulation is that we can 'get close' on the desktop and simply fine tune in the field. Simulation can save time and money.

There are lots of ways one might explore how to choose the feed line lengths. As might be expected, SimSmith provides the capability to run many simulations of many feed line lengths and then lets you choose. The capability is called 'multi-variable sweeping'. This article is not a SimSmith tutorial so only the result of the sweep is shown. Figure 15 shows the power delivered at 14.2 MHz as a function of feed line lengths. The marker shows one solution: E is 46 feet long and A is 22 feet long.

This simulation is based on an EZNEC model of the antenna and brings to focus the importance of various choices of feed line length. These lessons are now applied to an already lofted and tuned dipole.

The first step is to measure the antenna impedance. Using a convenient length of feed line, measure the impedance at the second harmonic. The goal is to adjust the feed line length so that the impedance is a maximum. The feed line length will probably need some adjustment. The amount of feed line to add (or remove) can be determined using SimSmith. Start up SimSmith, enter the measured impedance as the 'load' and add a piece of feed line. For example, suppose the measurement of the antenna indicated 2 + j15 ohms. Figure 16 shows a SimSmith circuit with the measured impedance entered as the load and an additional piece of feed line adjusted to maximize the impedance.

[*The sharp-eyed reader may note that a frequency of 10 MHz appears in Figures 16, 17 and 20. This is a default value in SimSmith that does not materially effect the results discussed in this article because of the way impedances are specified by the author. The results as discussed by the author in this paper are still valid. — Editor*]

An alternative to adding feed line is to subtract it. To determine how much to subtract, remember that adding or subtracting a half wave of feed line has essentially no effect on the impedance. In this case, a half wave length of feed line is very close to 23 feet, so removing 13.5 feet (23 – 9.5) is the same as adding 9.5 feet.

This is illustrated in Figure 17.

Add or subtract the calculated length of feed line and verify the impedance is 'high' and 'real'. While tuning can certainly improve performance, there is considerable tolerance in the length of this feed line.

This step effectively engineers the LOAD side of our filter.

It is now time to add the stub. The length of the stub is determined using the operating frequency and velocity factor. SimSmith contains a database of popular manufacturers' products. Figure 18 shows what SimSmith indicates for RG213 and RG-8X adjusted to suppress a second harmonic at 14.2 MHz. Notice the two lengths are different due to different velocity factors.

To construct the stub, cut a piece of the chosen coax about 10% long. Short one end and add a connector to the other. Measure the impedance paying particular attention to the reactance. The long cable should have a positive reactance. To tune the stub, progressively cut pieces from the end. Each time the coax is shortened it is important to reinstall the short. Proceed slowly; removing coax is much easier than adding! The reactance should be reduced each time the coax is shortened. If the reactance starts to climb (or turns negative) the tuning process is complete. Set it aside.

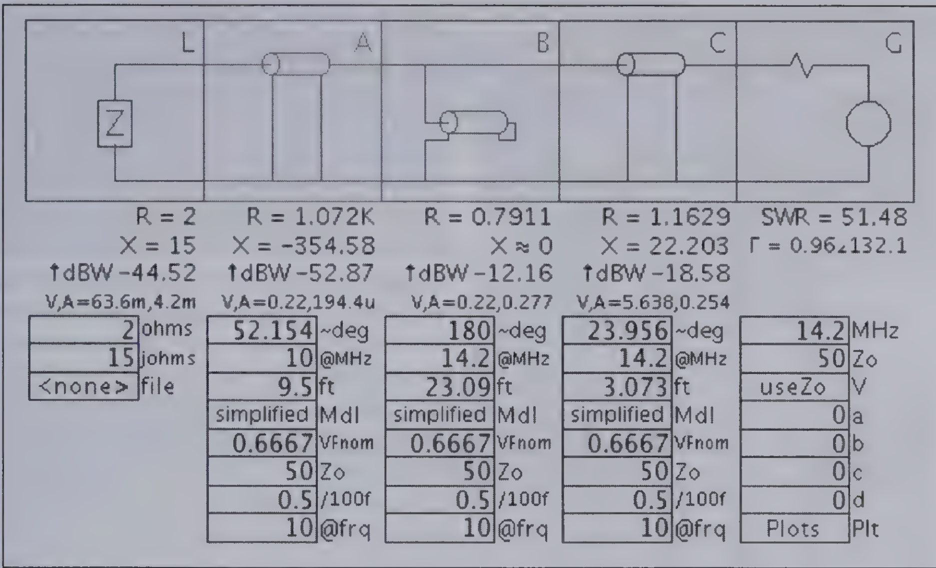


Figure 20—Final circuit with the antenna, the feed line to the antenna, the stub, and the feed line to the transmitter.

Now it is time to engineer the DRIVE side of our filter…

To do this properly, it is necessary to measure the impedance of the amplifier WHEN IN TRANSMIT MODE.

This step can be somewhat disconcerting because it requires connecting test equipment to a powered up transmitter. Commercial rigs generally have 'output power level' control. Make sure it is set to zero AND VERIFY that when you hit the 'tune' button, the transmitter truly delivers no power. Otherwise the test equipment may well be damaged.

For most home built rigs, the output network is always being used along with any antenna tuner. In this case, it is safe to connect the test equipment directly. Take whatever measures ensure the transmitter will not accidentally be turned on; disconnect the CW key, for example.

Remember that the transmitter should be tuned to the fundamental operating frequency but that the test equipment is measuring impedance at the second harmonic.

There is considerable latitude in the length of the feed line going to the transmitter so generally tuning is not necessary. To get close one can, of course, use a program such as TLW, TLDetails or SimSmith. As an example, suppose the impedance measured as 80 + j60. Simply put the results of the measurement in the circuit as the 'load', add a feed line, and tune the length just as was done when adjusting the feed line to the antenna. Figure 19 shows the circuit again with the impedance of the transmitter entered and the feed line length adjusted for maximum.

Once the three pieces of coax have been tuned, connect them all together with a T. Figure 20 shows the resulting circuit.

Notice that the Pi network has been removed. This is because actual measurements of the transmitter output impedance have been performed. The measured impedance is shown under the circuit element on the right using the 'a' and 'b'parameters.

To verify things are working properly it is easiest to use a second receiver. Connect everything, set the transmitter power to a moderate level and 'key down'. Listen for the harmonic on the second rig. Listen with the stub connected and with the stub disconnected. There should be a noticeable difference and you should be ready to go.

Occasionally, there will be no difference detected between 'stub connected' and 'stub not connected'. Should this happen the chances are that there is other leakage from the transmitter to the second rig. Make sure all grounding and shielding is properly installed and that power supplies are independent. Remember, there are many ways signals can leak out of, and into, your rigs.

Once shielding and grounding have been properly employed, the spurious second harmonic should be greatly reduced and neighbors and fellow operators can work without interference.

US QRP Frequencies (some are different in Europe)

Band	***CW***	***Phone***
160m	1810 kHz	1910 kHz
80m	3560 kHz	3690 kHz
60m	5346.5 kHz (Ch 2)	
40m	7030 kHz	7285 kHz
30m	10106 kHz	
20m	14060 kHz	14285 kHz
17m	18096 kHz	18130 kHz
15m	21060 kHz	21385 kHz
12m	24906 kHz	24950 kHz
10m	28060 kHz	28385 kHz
6m	50096 kHz	50185 kHz
2m	144060 kHz	144285 kHz

Antennas 101: Fun With Fiberglass (from 2006)

Gary Breed—K9AY
k9ay@k9ay.com

This is the first of two columns from 2006, with antenna construction ideas for lightweight antennas. The first is from the Winter (January) 2006 issue of QQ...

Way back in 1973, while browsing through a tackle shop in northern Wisconsin, I saw a 16-foot telescoping fiberglass fishing pole—and immediately thought “antenna!” Fiberglass has all the attributes we want in an antenna. It’s lightweight, strong, fairly stiff but flexible enough to give way to strong winds. Fiberglass is not an electrical conductor, but a wire run through the center or wrapped around the outside takes care of that little problem.

As I soon found out, the challenges with making an antenna from a fiberglass fishing pole are almost all mechanical—how are things attached to one another and to the supporting mast? How is the wire routed through the assembly? This article (and the next one or two) will emphasize the methods I’ve developed over the years for working with these poles.

Figure 1—From left to right: a Silstar 3002 pole, SD-20 pole, SD-17 pole, and an Eagle Claw two-piece rod blank.

What’s Available?

Fiberglass fishing poles are not hard to find, but not always front-and-center in your local sporting goods store. I’ve found them both prominently displayed and buried on a bottom shelf. I’ve found them at both large sporting goods chains and small fishing tackle shops. Occasionally, I also see them in the sporting goods section of the “big box” general retailers.

Most of us want the maximum length pole available. Here are the major brands and models to look for:

South Bend (www.south-bend.com)—The SD-20 “Sunny Day” pole is probably the most well-known, since it was sold for a while by *WorldRadio* magazine. It is a strong graphite composite pole that I really like. There are models from 10 ft. to 20 ft. in the SD-*xx* line. I bought a quantity of the SD-20 a few years ago directly from South Bend, but it does not seem to be as easy to find in stores as it once was.

B’n’M Poles (www.bnmpoles.com)—The Black Widow line has four models from the BW3 at 10 ft. to the BW6 at 20 ft. There are other product lines from this company, including Buck’s and Tuff-Lite. This brand seems to be the most widely available; I’ve seen them at many retail sporting goods stores.

Shakespeare (www.shakespeare-fishing.com)—This well-known fishing gear company makes the Wonderpole line of 10 ft. to 20 ft. telescoping poles. These are also quite easy to find at many major sporting goods stores.

There are other brands and models, but those listed above are probably the most common. About 15 years ago I bought a dozen Silstar 3002 6-meter (19-1/2 ft.) poles, but these do not seem to be distributed any longer. Some sports stores also have their own “house brand” poles, which are often made by one of the above companies. Figure 1 shows a few of the poles mentioned.

If you don’t need a 16- or 20-footer, blanks for standard-length fishing poles are often available from the major manufacturers. They can be ordered through a local store or online retailer. Some time ago, I came across some 9-foot Eagle Claw two-piece blanks in the back of a local bait and tackle shop. They were on sale for three bucks apiece, so I bought them all—and still have many of them.

Making a Pole into an Antenna

Whether you are making a vertical, a dipole or a multi-element Yagi, the main problem using these poles always seems to be mechanical assembly. The rest of this article will describe some techniques I’ve developed to prepare the pole for mounting and attaching the wires.

First, we’ll work on the large end of the pole. At the butt end of all the poles I’ve seen, there is a plastic cover with a screw-on cap. Let’s get rid of it! I unscrew the cap and remove the smaller sections, then use a hacksaw to carefully cut a slot in the plastic end piece, trying not to cut into the fiberglass (Figure 2).

The brittle plastic and the hard glue commonly used at this point should come apart easily with some firm persuasion, such as a screwdriver wedged into the slot you just cut (Figure 3).

Now you have the end of the fiberglass tubing exposed and ready for the next step. The 20-foot poles are usually a little more than 1-1/4 inches outside diameter at the end, and they start tapering immediately. The combination of odd size and taper prevents them from easily telescoping into standard tubing.

To make the ends compatible with more typical antenna assembly, I install a 1-foot sleeve of tubing over the large end of the pole. 6 inches of the tubing overlaps the large end of the pole, leaving the other 6 inches for mounting or attaching to additional lengths of tubing. I typically use 1-1/2” x 0.58” wall aluminum tubing. I have also used 1-1/2” x 1/8” wall fiberglass tubing, but it requires some machining to bore out the inside to match the pole outside diameter. See Figure 4.

Attaching the sleeve to the end of the pole takes a little fitting. The aluminum tubing is larger than the pole, so the space between them needs to be filled. First, I wrap ordinary black electrical tape around the end of the pole until the tubing slides on easily, but with snug fit.

Near the other end of the 6-inch overlap section, a similar wrapping of tape is made. I leave about 1/4 inch between this tape shim and the spot where the aluminum tubing will cover 6 inches of the pole. Exactly at 6 inches, I put a couple

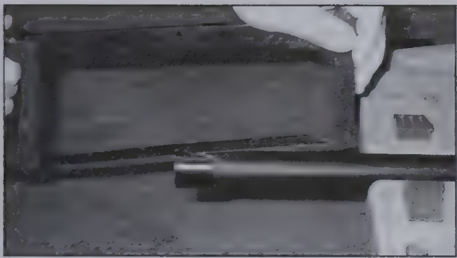


Figure 2—Cut a slot in the end cap assembly to facilitate its removal.

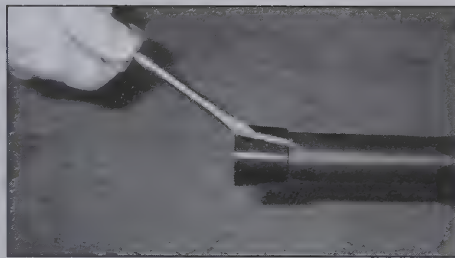


Figure 3—Using a screwdriver as a wedge, pop apart the plastic cap base.

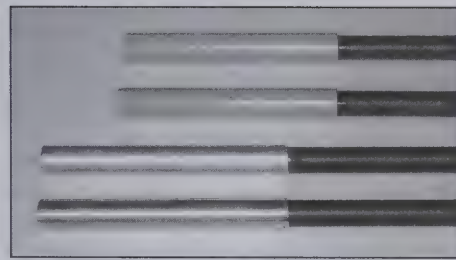


Figure 4—Tubing sleeves convert the pole ends to a standard diameter.

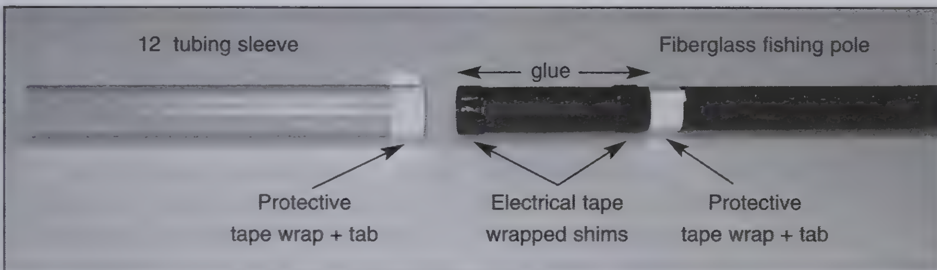


Figure 5—Photo of the tubing sleeve and fiberglass pole, ready to be glued together with epoxy or silicone.

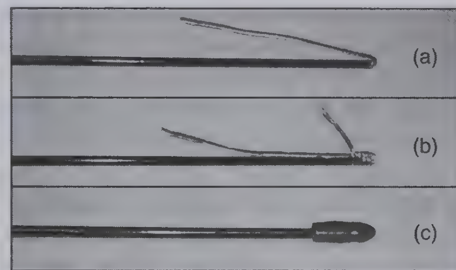


Figure 6—One way to secure the end of an antenna wire run inside the pole.

wraps of masking tape to mark the spot. At the end of this wrap, fold a half inch of the masking tape back onto itself to make a tab you can grab later—we'll see why shortly.

The final prep work is to place a wrap of masking tape around the outside of the tubing section, at the end that goes onto the pole. Make a folded-over tab at the end of this tape, too.

Figure 5 is a photo of the prepared tubing and pole. It's not as hard to make as the verbal description sounds!

The next step is to slide on the tubing while filling the gap with glue. For high-reliability antennas, such as my 40M Yagi, I use a good quality epoxy, but RTV or similar silicone sealant will be acceptable for almost any use. Work the glue into place as you slowly slide on the tubing. Let some excess build up on the leading edge to help get a good fill.

Once the tubing has been placed exactly at the marked location, set the assembly aside where it won't be disturbed. Keep it level so nothing slides apart before the glue cures. Now we'll use those tabs on the masking tape! Carefully unwrap the tape on the pole, lifting off the excess glue along with it. Then remove the tape on the end of the tubing sleeve, taking off the glue that is stuck to it. Depending on the type of glue used, apply heat or just leave it alone to cure. When using silicone sealant, the glue at the innermost part of the assembly may take a long time to fully cure; I recommend heating to speed the process. A small lamp or drop light with the bulb placed close to the sleeve will warm it up nicely. Leave it there all day or overnight.

Antennas Need Wire, Too!

Stranded wire works best, because the fiberglass can flex a lot in the wind and portable antennas will have the wire rolled and unrolled many times.

For portable antennas, wire attachment is easy, using the loop provided at the small end to tie a fishing line to the pole. Flapping in the wind can be eliminated by making a few spiral wraps around the pole.

On permanent antennas, run the wire inside the fiberglass pole, both for appearance and to reduce the wind load. This is a little more complicated than simply wrapping around the pole. Figure 6 illustrates the procedure that I use to secure the wire at the small end of the pole.

I use #14 bare stranded wire. Sure, it's overkill and smaller wire is probably just as good for longevity, and even—gasp!—QRO power. For any wire, the smallest section of the pole will need to be cut back a few inches, where the inside diameter is large enough to let the wire poke out the end. Be sure the total length of wire is a couple feet longer than needed, just to be safe. You can cut it to length later.

Feed one end of the wire through the small section and let about three inches stick out the end. Bend the excess back over the outside of the pole. Separate two or three strands from the rest of the wire and wrap them around the wire and tip of the pole until you have about 1/2" to 3/4" of a neatly finished end. Trim off the excess, heat up your soldering gun and flow some solder into the wire to lock it all together. When cool, dab some silicone sealant to make a "boot" or find a small flexible end cap for a more finished look.

Extending the Pole

OK, now we have a telescoping fiberglass pole with a wire that can be pulled inside as it is extended. For short-term portable operation, a friction-fit between the extended sections should be OK. If you expect windy conditions or a longer stay, wrap each joint with a couple turns of electrical tape. An "unwrapping tab" makes un-taping quick and easy.

For permanent antennas, you may want permanent joints. After I was sure that no further changes would be made, I epoxied all the pole section joints on my two-element 40M Yagi.

In the next article, we'll finally build something with RF running through it. In the mean time, search those fishing gear stores to find the right telescoping pole for the antenna you want to make!

●●

Antennas 101: Fiberglass for Forty (from 2006)

Gary Breed—K9AY k9ay@k9ay.com

Here is the next article on this topic, from the Summer 2006 issue of QQ. In 2007, the 2-element 40M beam described here was installed at 75 ft. height, and is still in operation today—having withstood nine years of Wisconsin weather!

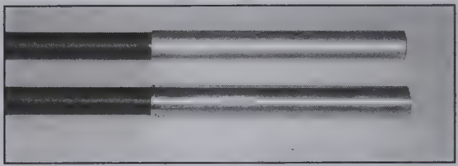


Figure 1—To begin, prepare the ends of fiberglass poles as described in Winter 2006 *QQ* and at FDIM 2006.

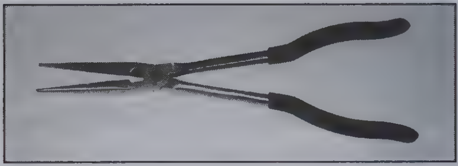


Figure 2—To work with hardware inside the tubing, these "bargain bin" extra-long needle-nose pliers are great!

My past few columns, along with a talk at FDIM this past May (2006), covered dipoles, rotatable dipoles, and techniques for building antennas with fiberglass. For this issue, we'll put it all together in a 40M rotatable dipole that can be expanded to a Yagi beam.

I have had one version or another of a "fishing pole" antenna for 40M continuously since 1990. All of survived plenty of wind and weather. These antennas may be lightweight, but they will last.

Let's Build Half of a Dipole

I think the best way to build a large rotatable dipole is half an element at a time. Two of them mounted to a center element-to-mast clamp makes a complete antenna. Actually, a half-element makes a pretty good vertical, too.

In the last article, I showed how to install a sleeve for reinforcing and standard-size interface at the large end of a fiberglass pole. For my most recent version of the 40M antenna (a 2-element Yagi), I used 12-inch lengths of 1-1/2" O.D. aluminum tubing for the sleeves, installed on SD-20 poles. The end of the pole was epoxied into place halfway into the sleeve, so there was a 6-inch overlap on the pole, and a 6-inch section that was only tubing. I now had four poles with ends that looked like the photo in Figure 1.

After the epoxy cured, each pole was extended to its full length. At the small end, the tips were trimmed back until the inside diameter was large enough for #14 bare stranded wire. I cut all poles to exactly the same length, then disassembled them, keeping the various sections of each pole together.

My antenna is for permanent installation, so I wanted the pole sections permanently bonded. Using a *very* thin layer of epoxy at each joint, each pole section was glued to the next—you need to put the glue on the overlapping part of the smaller section, then push it into place inside the next larger section. Use plenty of force, along with a twisting motion to seat each joint firmly at its maximum extension. If you don't, you may end up with weak joints, or a pole that is a couple inches shorter than expected. Don't attach the smallest (tip) pole section yet—it's easier to install later on, along with the wire. Set aside the glued-up pole where the epoxy can harden undisturbed. Some extra heat, such as the noonday sun, speeds up the process.

Running the Wire Inside the Poles

The next step was to place the wire inside the poles. I considered this a critical step, since this was intended to be a high performance antenna and wanted it to last a long time. I cut four lengths of #14 bare, stranded copper wire to the length of the pole/sleeve assemblies, with about a foot of extra length. I simply used bulk insulated wire from a local home center, with the insulation removed to reduce the weight and minimize sag of the poles. With care, the insulation can be sliced off with a utility knife. At one end of each wire, I crimped and soldered a #10 lug. This provides a means of attaching the wire to the tubing sleeve.

As you will see shortly, my antenna needed to have the 1-1/2" sleeve mate to 1/1/4" fiberglass tubing in the loading coil. I mention this now because I needed to place a 6-inch piece of 1-3/8" aluminum tubing inside the sleeve to provide the proper size I.D. I drilled a 3/16" hole through both the aluminum tubing sleeve and inside shim section. This hole is only through one wall of the tubing, from the outside to the center. Measure carefully to place the hole very close to the point where the sleeve and fiberglass meet, or about 1/2" from the inner end of the added 6" piece of 1-3/8" tubing. This location will leave 5 inches of overlap inside the sleeve, which is sufficient for a strong joint.

Now is the time to put the tip section of the pole into place. Push the cut end of the #14 wire into this section from the larger end, then just bend over a couple inches sticking out the end of the tip. This will keep the wire from pulling out. Put glue on the large end of the tip section and feed it—with wire attached—through the rest of the pole and out the end. Pull and twist to seat this last section.

Let the glue cure completely. You now have a solidly-glued full length (20 ft.) pole with a wire placed loosely inside.

Now comes the trickiest part of the entire project—attaching the end of the wire with the lug to the *inside* of the sleeve. I bought an extra-long pair of needle-nose pliers just for this type of work (Figure 2)—I've often seen these in the "cheap" tool displays at many hardware stores. The required hardware (stainless steel) is a 1" long 10-32 machine screw, two lock washers and one nut.

Figure 3 shows the pole end end assembly, including this screw. This is one of those jobs that is harder to describe than to perform, although it takes a steady hand. Put the screw through the hole in the sleeve, place one lockwasher over it, then the terminal lug of the inner wire. The long pliers noted earlier make it easy to reach into the tubing and place the hardware. The other lockwasher and the nut then complete the assembly. The first lockwasher isolates the dissimilar copper and aluminum metals, as well as providing resistance against twisting as the screw is tightened. The other lockwasher has the job of keeping the nut in place during the expected vibration of the antenna after it is installed—Like me, I expect that you want

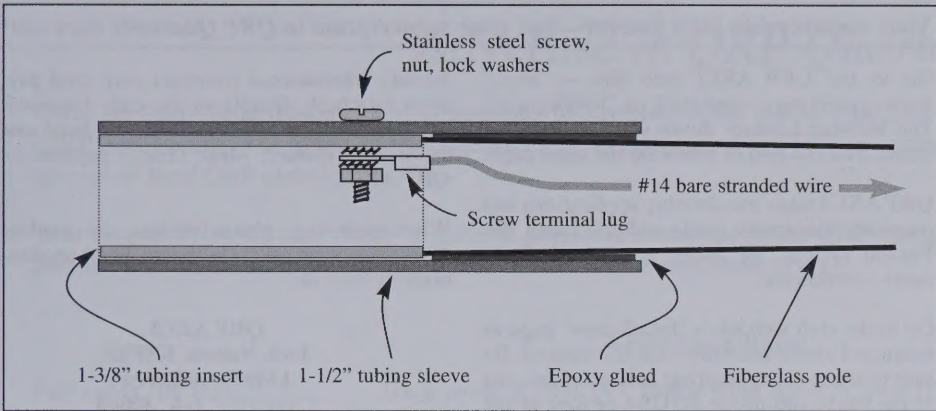


Figure 3—Cross-section drawing showing details for attaching the wire inside the sleeve. With a second, smaller diameter piece of aluminum tubing, I got the needed 1-1/4" I.D. to mate with the loading coil assembly.

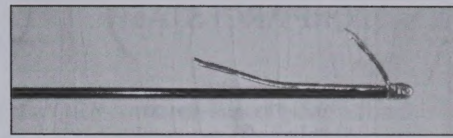


Figure 4—The end of the antenna wire can be secured by "serving"—winding a few strands over the rest of the wire—then flowing a little solder into it.

it to last a long time without something coming loose! Also, a dab of thread locking compound will help secure things, too.

Back at the tip end of the pole, pull the wire out until it is tight, then push about an inch back into the tubing. Bend over the excess and cut off all but about 3 inches. This end can be terminated any way you like; I usually separate a few strands and make a "served" end like Figure 4.

Finally, you have a complete pole section that is ready to become an antenna!

The Loading Coil

The main concern about a loading coil placed out on an antenna element is strength, since they are part of the structure as well as having an electrical function. I used two pieces of fiberglass tubing—a 1-1/4" inner piece for support and attachment to aluminum tubing, and a 1-1/2" piece for the coil form, since it is a bit larger diameter and will make a higher-Q coil. Figure 5 shows how it is assembled. For my design, the coil is 11 turns of ordinary #12 insulated wire. Since I was making a 2-element beam, I was careful to make four identical loading coils.

I used two telescoping pieces of aluminum tubing—approx. 3 feet each of 1-3/8" and 1-1/2" OD, 0.058" wall—to complete each half-element. I wound the loading coil to achieve resonance with about 4-1/2 feet of aluminum, plus the loading coil and pole assembly. A complete element (two of the above half-elements) is very close to 50 feet long, which is 73% of a full size 40M dipole. There is enough overlap between the two center aluminum tubing sections to adjust the frequency to anywhere in the 40M band. Of course, you can choose a different overall length and adjust the number of loading coil turns as needed.

Mounting to the Mast

The two half-elements are mounted using the typical aluminum plate and U-bolt method (Figure 6). Insulation is provided by PVC or ABS plastic pipe. To adjust the diameter, I slice pieces of plastic pipe lengthwise, and fill the gap with silicone sealant when assembled.

Final Assembly

Hey! This is a simple dipole, so tuneup is easy. Yes, there is some trial and error in winding the loading coil and finding the right length of the additional aluminum tubing sections, but it's not all that hard.

The weight of a full element is about 9 lbs., not including the center plate. My complete 2-element beam, with a 2-inch O.D. boom, weighs 32 lbs.

Notes on Making a Beam

I'm not going to detail the entire process—but the obvious first step is to make a second, identical, dipole.

Why identical? although the parasitic element has different tuning, the relationship between the two elements is known, e.g., a reflector is about 3.5% longer than the driven element. With identical elements, the added length can be provided with a 2.5 ft. "hairpin" loop in the center of the reflector. Then, the driven element can be adjusted with the telescoping tubing, and the changes simply duplicated on the reflector element. The hairpin will maintain the required difference.

Matching and testing a beam are beyond the scope of this article, but are covered quite well in the ARRL *Antenna Book* and other references.

Although I don't expect you to copy my exact antenna design, I hope some of these construction techniques will help when you build a lightweight fiberglass antenna for your QTH! ●●

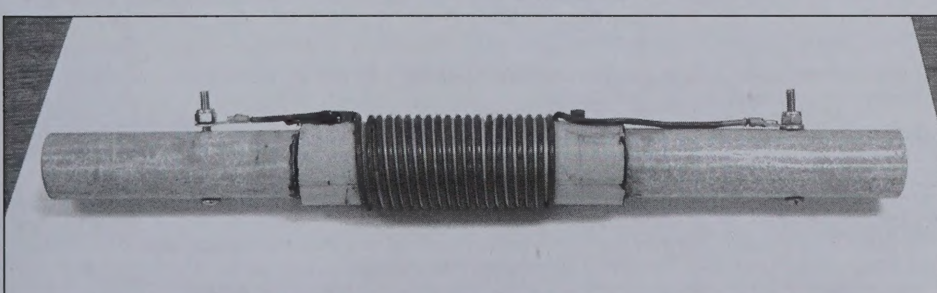


Figure 5—The loading coil is wound on a fiberglass tubing form, using ordinary #12 wire. To get a little wider spacing between turns (and keep them even) I wound a length of plastic lawn trimmer cord along with the wire.

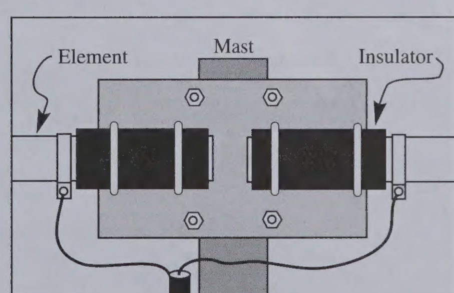


Figure 6—An aluminum plate, U-bolts and plastic pipe attach things at the center of the dipole.

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